Lesson no. 33 Rehaan (Sweet Basil)

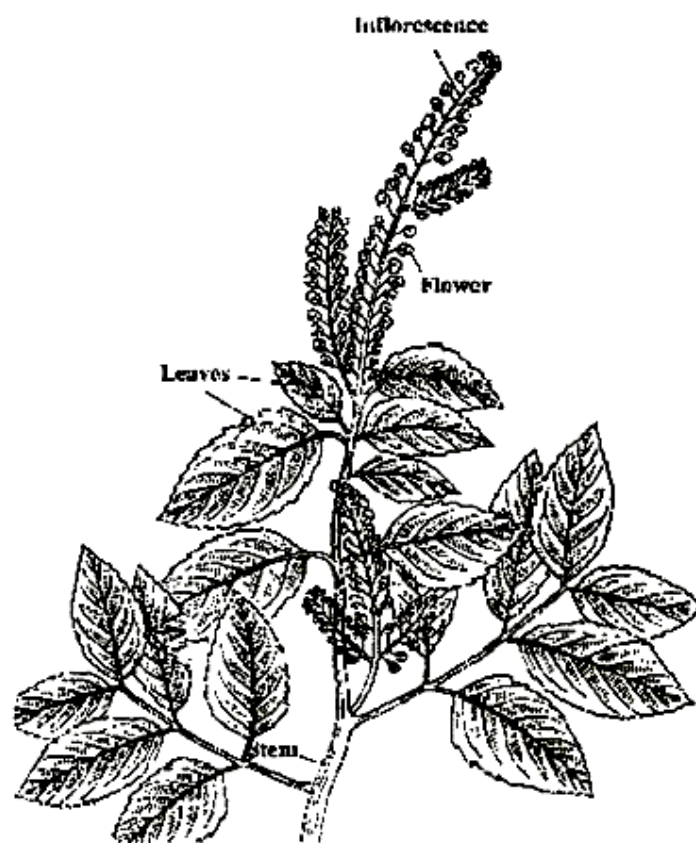



Fig. 3: *Ocimum sanctum*

Basil is botanically called as Ocimum basilicum & belongs to Lamiaceae family; it is also called as great basil or sweet basil etc; it is native to tropical regions from central Africa to Southeast Asia. It is a tender plant, and is used in cuisines worldwide. Depending on the species and cultivar, the leaves may taste somewhat like anise, with a strong, pungent, often sweet smell. There are many varieties of basil, as well as several related species or hybrids also called basil. The type used commonly as a flavor is typically called sweet basil (or Genovese basil), as opposed to Thai basil (*O. basilicum* var. *thyrsiflora*), lemon basil (*O. citriodorum*), and holy basil (*Ocimum tenuiflorum*). While most common varieties of basil are treated as annuals, some are perennial in warm, tropical climates, including holy basil and a cultivar known as "African blue basil". The exact taxonomy of basil is uncertain due to the immense number of cultivars, its ready polymorphy and frequent cross-pollination (resulting in new hybrids) with other members of the genus Ocimum and within the species. Ocimum basilicum has at least 60 varieties, which further complicates taxonomy.

Several other basils, including some other Ocimum species, are grown in many regions of Asia. Most of the Asian basils have a clove-like flavor that is, in general, stronger than the Mediterranean basils, such as tulsi. Lemon basil has a strong lemony smell and flavor very different from those of other varieties because it contains a chemical called citral. It is widely used in Indonesia, where it is called kemangi, served raw together with raw cabbage, green beans, and cucumber as an accompaniment to fried fish or duck. Its flowers, when broken up, are a zesty salad condiment.

Rehaan (Rayhan) (الريحان) means sweet smelling plants. It is not one type of plant, Allah has gifted every region a sweet smelling plant, according to their needs, and they all come under the topic of Rehaan (Rayhan) (الريحان) means every region grows sweet smelling plants of its own kind by the grace of Allah.

Rehaan is mentioned in Quran at 2 places chapter 55 sura Rahmaan verse 12; & chapter 56 sura Waaqia verse 89; it is mentioned in many Hadith; in Hadith it is said that in Jannah there will be Rehaan plants; it is also mentioned not to refuse Rehaan if gifted because it is from Jannah; for detail Islamic study on Rehaan please read my English book tibb e nabawi part 2 lesson 46 page 127 onwards; or visit my website www.tib-e-nabi-for-you.com or direct link to lesson Rehaan on my website http://www.tib-e-nabi-for-you.com/rehaan.html

- ***Basic encyclopedia of basil: -***
- ***NAMES: -***

1. The word Rehaan (Rayhan) (الريحان) means sweet smelling plant.
2. Hindi it is called as Tulsi.
3. In it is called Rehaan (Rayhan) (الريحان) in Hadees, Quran & Arabic.
4. In English it is called as Sweet basil, Myrtle.
5. In Sanskrit it is called as Vishwa Tulsi.
6. In Hindi, Gujrati & Urdu it is called as Sabza.
7. In Marathi it is called as Tukmaria.
8. In Latin it is called as Ocimum basillicum.
9. Family is Lamiaceae.

- ***In Quran it is mentioned in following Sura/verses: -***

1. Chapter No. 55 (Surah) Rahmaan verse no. 12: -

وَالْحَبُّ ذُو الْعَصْفِ وَالرَّيْحَانُ

& also corns, with leaves & stalks for fodder & sweet-scented plants.

2. Chapter 56 (Surah) Waaqia verse no. 89: -

فَرَوْحٌ وَّرَيْحَانٌ وَّجَنَّةُ نَعِيمٍ

For him are the comfort & flower & a garden of delight.

It is mentioned in following books of Hadith (names of book of Hadith & reference are also given): - Bukhari : 5427; Tirmizi : 3021; Muslim : 2253, Kanzul-ummal : 39268; Mishkat : 1627 & 6145.

- ***Basil Plant: -***

Basil is an annual or sometimes perennial herb; it is used for its leaves. Depending on the variety, plants can reach between 30 cm (0.98 ft) and 150 cm (4.9 ft). Basil grows a thick, central taproot. Basil is sensitive to cold, with best growth in hot, dry conditions. It behaves as an annual if there is any chance of a frost. However, due to its popularity, basil is cultivated in many countries around the world. It grows best outdoors but can be grown indoors in a pot; it should be kept away from extremely cold drafts, and grows best in strong sunlight, therefore a greenhouse or row cover is ideal if available. It can, however, be grown even in a basement, under fluorescent lights. It also thrives over the summertime in the central and northern United States, but dies out when temperatures reach freezing point. It will grow back the next year if allowed to go to seed. It will need regular watering, but not as much attention as is needed in other climates. Basil can also be propagated reliably from cuttings with the stems of short cuttings suspended for two weeks or so in water until roots develop.

Once a stem produces flowers, foliage production stops on that stem, the stem becomes woody, and essential oil production declines. To prevent this, a basil-grower may pinch off any flower stems before they are fully mature. Because only the blooming stem is so affected, some stems can be pinched for leaf production, while others are left to bloom for decoration or seeds.

Once the plant is allowed to flower, it may produce seed pods containing small black seeds, which can be saved and planted the following year. Picking the leaves off the plant helps promote growth, largely because the plant responds by converting pairs of leaflets next to the topmost leaves into new stems.

- ***Basil leaves: -***

Its leaves are richly green and ovate, opposite, or light green, silky leaves broad, but otherwise come in a wide variety of sizes and shapes depending on cultivar. Leaf sizes range from 3 cm (1.2 in) to 11 cm (4.3 in) long, and between 1 cm (0.39 in) and 6 cm (2.4 in) wide.

- ***Basil flower: -***

Basil flowers are small and white, and grow from a central inflorescence that emerges from the central stem atop the plant; flowers are arranged in a terminal spike; the four stamens and the pistil are not pushed under the upper lip of the corolla, but lie over the inferior lip. After entomophilous pollination, the corolla falls off and four round achenes develop inside the bilabiate calyx. As there are many types of basil plant, the above pics are of different type of basil flower.

- ***Basil seeds: -***

The basil seeds that are used for eating are the seeds from the sweet basil plant, *Ocimum basilicum*. They are also called Thai basil seeds, falooda, sabja, subza, selasih or tukmaria. It is lot of health benefits.

The sweet basil seeds helps in weight loss; reduces body heat; controls blood sugar level; relieves constipation and bloating; treats acidity and heartburn; good for skin and hair; cures cough and flu etc. Seeds soaked in water of several basil varieties become gelatinous. They are used in Asian drinks and desserts such as falooda or sharbat. They are used for their medicinal properties in Ayurveda, the traditional medicinal system of India.

- ***Basil pod: -***

Basil seed pods containing small black seeds, which can be saved and planted the following year.

- ***Basil oil: -***

Basil essential oil is said to enhance mood, improve digestion, increase alertness, and soothe muscle aches. Basil essential oil is also sometimes used as an insect repellent. It is good for liver diseases, viral infections, basil essential oil emits a warm, sweet, freshly floral and crisply herbaceous scent that is further characterized as airy, vibrant, uplifting, and reminiscent of the scent of licorice. It is good for skin, complexion, joint pain, skin diseases, wounds, ulcers, improves moods, helps heart, lungs etc.

- ***Different types of basil: -***

1. Genovese Basil (sweet basil): -

Genovese basil, one type of basil very common; it is infinite in its uses. It is Italian basil; delicious; one can blend up some Genovese basil and make a tasty pesto, or put some leaves in hot water for a flavorful tea.

2. Purple Basil: -

Purple basil, most often used as an embellishment on a dish, has a flavor that is quite similar to that of regular basil. One defining feature is the rich purple color of the entire plant, including both the leaves and stems. This type of basil is a beautiful addition in drinks like lemonade and juice. The strong fragrance and brilliant color will immediately draw attention to the herb.

<u>3. Cinnamon Basil: -</u>

Cinnamon basil, delicious and aromatic in desserts, contains a chemical called methyl cinnamate, which gives it that warm flavor. It is also known as Mexican basil, and has dark green and shiny leaves. One can blend up some cinnamon basil and put it on rice pudding, or could dry this herb out and use it in potpourri because of its strong, barky aroma.

<u>4. Holy Basil: -</u>

Holy basil, a natural antioxidant known for its medicinal properties, is also called Tulsi and is traditionally from India. In Hindu culture, it is considered a sacred plant, and is often planted around shrines and monuments. It is a perennial (different from the more common basil), and this strongly scented herb can used to reduce stress or relieve headaches.

<u>5. Lemon Basil: -</u>

Lemon basil, delicious when eaten raw in a salad, is a hybrid type of basil, primarily grown in northeastern Africa and southern Asia. It is used in many dishes from Thailand and Malaysia. As the name suggests, this type has a citrus flavor and sweet aroma. It differs from lemon balm, which is part of the mint family, because it still has that traditional savory-basil taste to it.

<u>6. African Blue Basil: -</u>

African Blue basil, used in skin care products because of its high content of camphor, is another type of perennial basil. It is a hybrid of East African basil with the garden variety called Dark Opal. The leaves of this basil start off as deep bluish purple, but turn bright green as they mature. We like to put the African Blue basil plant right on the dinner table, and pick the leaves off as we eat. It looks gorgeous, so it acts as a decoration too.

<u>7. Spicy Globe Basil: -</u>

Spicy Globe basil, used to add a fiery hint in any dish, is shaped like a spherical bush (hence the name). It has smaller leaves than the more common types of basil, and this hybrid has both a savory and zesty flavor.

<u>8. Licorice Basil: -</u>

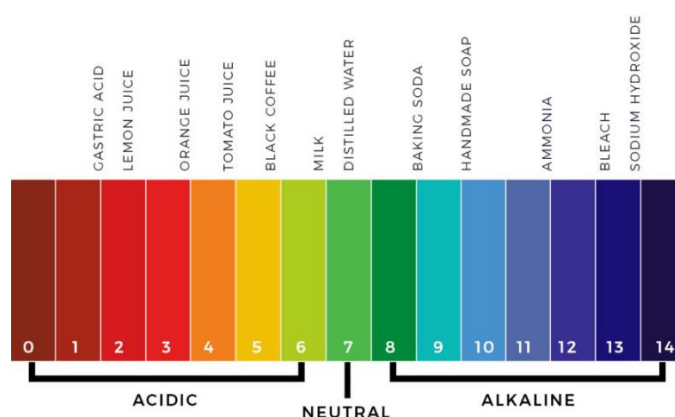
Licorice basil, a healthy alternative to licorice candy, has an intense anise flavor. The leaves of this variety are slightly pointed, and the plant is native to India and ancient Persia. With a little bit of honey and some hot water, a cup of licorice basil tea could be the delicious replacement for anyone with a sweet tooth.

<u>9. Dwarf Greek Basil: -</u>

Dwarf Greek basil, interestingly used an insect repellent, has very small leaves, and also grows into a spherical shaped bush. It is also called bush basil, and has a savory flavor. Since this type of basil has such small leaves, it is easily dried and tastes excellent sprinkled on garlic bread or in a soup or stew.

- ***<u>pH of basil leaves is: -</u>*** 5.5 to 6.5; it is mild acidic because its pH is little less than 7.

pH is a measure of hydrogen ion concentration, a measure of the acidity or alkalinity of a solution. The pH scale usually ranges from 0 to 14. Aqueous solutions at 25°C with a pH less than 7 are acidic, while those with a pH greater than 7 are basic or alkaline & 7 is neutral; only aqueous solutions have pH levels, vegetable oil has no pH value. Likewise, other oils such as animal and

petrochemical oils also have no pH value. Fatty acids are organic molecules often found in foods, including vegetable oils.
The pH of pure water is 7. In general, water with a pH lower than 7 is considered acidic, and with a pH greater than 7 is considered alkaline. The normal range for pH in surface water systems is 6.5 to 8.5, and the pH range for groundwater systems is between 6 and 8.5. We can add normal water to reduce the acidity.
It is Sunnat of Prophet Muhammad (s.a.w) to mix acidic with Alkaline to make it neutral or less acidic that why He use eat dates with watermelon or cucumber or dry dates with little butter; so you can mix one acidic with alkaline; also it is Sunnat to drink honey mixed in water; also dates or raisins soaked in water over night & drink the syrup (sharbat). Remember do not soak dates & raisin together at one time; soak at separate time & drink.

- ***Calories of basil: -*** 100 grams of it gives only 22 calories.
- ***Glycemic index & Glycemic load of it: -*** It is low glycemic index & load, but the right valve is not fully known because we do not eat basil in bulk at one time.

A food is considered to have a low Glycemic index (GI) if it is 55 or less; mid-range GI if 56 to 69 & high GI if 70 or more. *Glycemic index* is a number. It gives you an idea about how fast your body converts the carbs in a food into glucose.
A low Glycemic load (GL) is between 1 and 10; a moderate GL is 11 to 19; and a high GL is 20 or higher. For those with diabetes, you want your diet to have GL values as low as possible.
The *glycemic load* (GL) of food is a number that estimates how much the food will raise a person's blood glucose level after eating it. *Glycemic load* accounts for how much carbohydrate is in the food and how much each gram of carbohydrate in the food raises blood glucose levels.

- ***Gross health benefits of basil: -***

Good for digestion, anti-inflammatory, fights free radical activity, good for skin, hair, nails, fights depression, helpful in diabetes management, supports liver function and helps detoxify the body, promote healthy gut. Good for wounds; internal diseases; jaundice, pneumonia, cough & clod, bronchitis etc. it is very helpful in viral, bacterial & fungal infection, helpful in all skin diseases etc.

- ***Clinical pharmacology of it: -***

Anti-inflammatory activity: -
In vitro and animal data
Limited animal studies report anti-inflammatory activity of O. basilicum essential oil, including reductions in leukocytes in rats and mice with experimentally induced colitis and arthritis, respectively. Both the essential oil and the single component estragole showed efficacy in reducing histamine- and arachidonic acid–induced paw edema in mouse models. Additionally, in vitro experimental studies suggest that extracts of O. basilicum or its fractions may exert an influence on COX enzyme activity and on prostaglandin and thromboxane production.
Clinical data
Research reveals no clinical data regarding the use of sweet basil as an antithrombotic or anti-inflammatory agent.
Antimicrobial activity: -
In vitro and animal data

In vitro studies report activity of the essential oil against human and plant pathogens. Sweet basil essential oil was not active against fluconazole-resistant Candida spp.
Laboratory experiments suggest that the oil may be an alternative to common synthetic repellents and/or acaricides, likely due to constituents such as alpha-pinene, limonene, citronellol, citronellal, camphor, and thymol. **Antiprotozoal activity: -** has also been demonstrated in vitro against Trichomonas vaginalis and Leishmania spp.

Clinical data

Research reveals no clinical data regarding the use of sweet basil as an antimicrobial agent or as a repellant or acaricide.

Antioxidant activity: -

Animal data

Antioxidant activity has been documented. A study in rodents reported improvements in cerebral infarct size, memory impairment, and motor coordination with pre-treatment with O. basilicum extract. Antioxidant activity may contribute to these observed effects.

Clinical data

Research reveals no clinical data regarding the use of sweet basil as an antioxidant agent.

Cardiovascular disease: -

Animal data

In a study in hypercholesterolemic rodents, O. basilicum extract exerted a vaso-relaxant effect. In another study on rats, O. basilicum leaf extract demonstrated protection against adverse outcomes of induced myocardial infarction; (eg, ST-segment elevation, fibrosis of myocardial tissue), possibly due to its antioxidant effects. Additionally, experimental studies in rodents suggest that sweet basil extracts may influence thromboxane production.

Clinical data

Research reveals no clinical data regarding the use of sweet basil in cardiovascular disease.

CNS: -

Animal data

In limited experiments in mice, extracts of O. basilicum demonstrated antianxiety and sedative effects, memory enhancement effects, and improvement in neuromuscular coordination.

Clinical data

Research reveals no clinical data regarding the use of sweet basil in diseases of the CNS.

Diabetes: -

In vitro and animal data

Limited in vitro and animal experiments suggest that the observed antidiabetic effects of O. basilicum may be due to alpha-glucosidase and alpha-amylase inhibitory activity.
In a study evaluating the toxicity of linalool in poultry, increased serum glucose was observed; however, the researchers considered this effect to have no biological importance.

Clinical data

Research reveals no clinical data regarding the use of sweet basil in the management of diabetes.
Other uses
In vitro studies report activity of the essential oil against cancer cell lines, including breast and cervical cancer; however, clinical studies are lacking. Based on molecular docking studies performed with proteins from the Anopheles gambiae mosquito, 12 compounds in O. basilicum and other Ocimum spp. potentially have significant mosquito repellent activity.

- ***Modern uses of it: -***

Basil is most commonly used fresh in recipes. In general, it is added at the last moment, as cooking quickly destroys the flavor. The fresh herb can be kept for a short time in plastic bags in the refrigerator, or for a longer period in the freezer, after being blanched quickly in boiling water. The dried herb also loses most of its flavor, and what little flavor remain tastes very different, with a weak coumarin flavor, like hay. Basil is one of the main ingredients in pesto—a green Italian oil-and-herb sauce.
The most commonly used Mediterranean basil cultivars are "Genovese", "Purple Ruffles", "Mammoth", "Cinnamon", "Lemon", "Globe", and "African Blue". The Chinese also use fresh or dried basils in soups and other foods. In Taiwan, people add fresh basil leaves to thick soups. They also eat fried chicken with deep-fried basil leaves. Basil (most commonly Thai basil) is commonly steeped in cream or milk to create an interesting flavor in ice cream or chocolates (such as truffles). The leaves are not the only part of basil used in culinary applications, the flower buds have a more subtle flavor and they are edible.
Seeds when soaked in water, the seeds of several basil varieties become gelatinous, and are used in Asian drinks and desserts such as *faluda*, *sharbat-e-rihan*.

Research studies of the essential oil showed antifungal and insect-repelling properties, including potential toxicity to mosquitos.

- ***For jaundice: -***

Put few drop of basil oil in both nose 3 times a day & few drops in warm water & drink this water 3 ties a days till complete relief.

- ***For cold & cough: -***

Take half teaspoon of basil leaf powder & mix it in little extra virgin oil & 1 teaspoon honey prepare a paste & lick it 3 times a day till complete relief.

- ***For general health: -***

Drink basil leaf tea add little honey in it once or twice a week at empty stomach early morning lifelong.

- ***Contents/constituents of***

All contents may not present in all types of it, because there are many varieties of it according to geographical regions & content may differ a lot as per cultivation, soil, seed, climate etc.

A good quality of basil contains little amount of amino acids mentioned in table below: -

The above ingredients are based on scientific study, means these has been identified, known & learnt by modern science, it does not means that it contains only these ingredients, there may be many more ingredients which are yet to be discovered, learnt & known by modern science.

The details given below are based on natural ingredients found in basil and not synthetically prepared.

Studies have elucidated the chemical composition of the essential oil are methyl cinnamate (70.1%), linalool (17.5%), β-elemene (2.6%) and camphor (1.52%) eugenol (39.3%), methyl chavicol (38.3%), terpinolene (7.7%), eugenol (4.5%), and cubenol (1.9%). Terpenic hydrocarbons (eg, cymene, limonene, myrecene, pinene, terpinene, phellandrene), aromatic phenols (carvacrol, eugenol, thymol, and safrol), ketones (menthone, pulegone, carvone and thujone, verbenone, and fenchone), alcohols (eg, borneol, carveol, geraniol, linalool, menthol, terpineol), aliphatic aldehydes (citral, citronellal, and perillaldehyde), acids (citronellic acid and cinnamic acid) and esters (linalyl acetate). However, concentrations of these components vary, depending on the source of the plant. The various basils have such different scents because the herb has a number of different essential oils in different proportions for various cultivars. The essential oil from European basil contains high concentrations of linalool and methyl chavicol (estragole), in a ratio of about 3:1. Other constituents include: 1,8-cineole, eugenol, and myrcene, among others. The clove scent of sweet basil is derived from eugenol. The aroma profile of basil includes 1,8-cineole and methyl eugenol.

The seeds of the plant contain ursolic acid, rosmarinic acid, caffeic acid, vallinin, stigmasterol, apigenin, and luteolin, among other components.

Country	Major constituents
Bangladesh	Methyl cinnamate, linalool, tau-cadinol, α-bergamotene, γ-muurolene, sulfone-methyl styryl, and methyl chavicol[12]
Brazil	Linalool, geraniol, and 1.8-cineole[13]
Czech Republic	Linalool, eugenol, 1,8-cineole, and bergamotene[14]
Guinea	Linalool, eugenol, α-bergamotene, and thymol[15]
Malaysia	Methyl chavicol[16]
Mississippi	Linalool, camphor, α-humulene, eucalyptol, eugenol, bornyl acetate, methyl chavicol, *trans*-caryophyllene, α-*trans*-bergamotene, and cadinol[17]
Northeast India	Camphor, limonene, and β-selinene[18]
Oman	Linalool, geraniol, 1,8-cineole, α-bergamotene, and geranyl acetate[19]
Poland	Linalool, 1,8-cineol, germacrene D, and β-elemene[20]
Romania	Linalool, elemene, farnesene, and guaiene in one sample, while *epi*-bicyclo sesquiphellandrene, farnesene, β-elemene, and γ-cadinene in another sample[21]
Southern, India	Methyl cinnamate, linalool, β-elemene, and camphor[22]
Thailand	Methyl chavicol[23]
Turkey	Menthone, estragole, isoneomenthol, menthol, pulegone, and linalool[24]; methyl chavicol, linalool, α-cadinol, germacrene D, and 1,8-cineole from Iran[25]; methyl eugenol, α-cubebene, nerol, and ε-muurolene[26]
USA	Linalool, estragole, methyl cinnamate, eugenol, and 1,8-cineole[27]

Table 2

Chemical composition of the essential oil of *Ocimum basilicum*

Compounds	RI	Area %	Identification
Sabinene	975	t	RI, MS
β-Pinene	976	0.1	RI, MS
Myrcene	990	0.3	RI, MS
Limonene	1029	0.2	RI, MS
Cineol-1,8	1031	2.1	RI, MS
(*E*)-β-Ocimene	1050	0.2	RI, MS
Terpinolene	1088	7.7	RI, MS
Camphor	1146	0.6	RI, MS
Borneol	1169	0.5	RI, MS
Terpin-4-ol	1177	0.1	RI, MS
α-Terpineol	1188	1.0	RI, MS
Methyl chavicol	1196	38.3	RI, MS
Isocarveol-dehydro	1214	0.2	RI, MS
Chavicol	1250	0.6	RI, MS
Eugenol	1356	4.5	RI, MS
α-Copaene	1376	t	RI, MS
β-Cubenene	1388	t	RI, MS
Methyl eugenol	1403	39.3	RI, MS
β-Copaene	1432	0.1	RI, MS
cis-Muurola-3,5-diene	1450	0.1	RI, MS
cis-Muurola-4 (14), 5-diene	1466	0.2	RI, MS
γ-Muurolene	1478	0.1	RI, MS
Methyl isoeugenol	1492	0.2	RI, MS
δ-Amorphene	1512	0.3	RI, MS
Cubenol	1646	1.9	RI, MS
Total identified		98.6	

Table 3

MBC values (mg/mL) of the essential oil of *Ocimum basilicum*

Microbial strains	MBC mean±SEM of essential oil	MBC mean±SEM of RA
Gram-positive		
Staphylococcus aureus	0.143±0.031	0.002±0.001
Staphylococcus epidermidis	0.416±0.161	0.002±0.001
Streptococcus faecalis	0.364±0.127	0.002±0.001
Micrococcus flavus	0.520±0.161	0.002±0.001
Micrococcus luteus	0.572±0.127	0.001±0.001
Bacillus subtilis	0.260±0.080	0.001±0.001
Gram-negative		
Escherichia coli	1.666±0.645	0.009±0.004
Enterobacter aerogenes	1.041±0.322	0.009±0.004
Klebsiella pneumoniae	1.875±0.684	0.005±0.002
Pseudomonas aeruginosa	0.937±0.342	0.004±0.003
Proteus vulgaris	0.833±0.322	0.005±0.003
Proteus mirabilis	0.781±0.382	0.002±0.001
Serratia marcescens	1.250±0.684	0.005±0.003
Salmonella typhimurium	1.562±0.765	0.012±0.002
Fungi		
Aspergillus niger	0.442±0.207	0.001±0.001
Aspergillus fumigatus	0.312±0.171	0.001±0.001
Penicillium chrysogenum	0.416±0.415	0.001±0.001

- ***Active components of it: -*** The major components of the volatile oil of sweet basil are linalool, cineole, and estragole (methyl chavicol), depending on the source. *Ocimum basilicum* L. contains linalool (54.95%), methylchavicol (11.98%), methylcinnamat (7.24%), and linolen (0.14%).

Each constituent of basil & basil oil explained separately: -

- ***Estragole: -***

Estragole (p-allylanisole, methyl chavicol) is a phenylpropene, a natural organic compound. Its chemical structure consists of a benzene ring substituted with a methoxy group and an allyl group. It is an isomer of anethole, differing with respect to the location of the double bond. It is a colorless liquid, although impure samples can appear yellow. It is a component of various trees and plants, including turpentine (pine oil), anise, fennel, bay, tarragon, and basil. It is used in the preparation of fragrances.

- ***Eugenol: -***

Eugenol is an allyl chain-substituted guaiacol, a member of the allylbenzene class of chemical compounds. It is a colorless to pale yellow, aromatic oily liquid extracted from certain essential oils especially from clove oil, nutmeg, cinnamon, basil and bay leaf.

- ***Methyleugenol: -***

Methyleugenol is a yellowish, oily, naturally occurring liquid with a clove-like aroma and is present in many essential oils. Methyleugenol is used as a flavoring agent, as a fragrance and as an anesthetic in rodents. Methyleugenol is mutagenic in animals and is reasonably anticipated to be a human carcinogen based on evidence of carcinogenicity in animals.

- ***Methyl isoeugenol: -***

Methyl isoeugenol (isomethyleugenol) is a phenylpropanoid, the methyl ether of isoeugenol, found in certain essential oils. It can occur as both (*E*)- and (*Z*)-isomers.

- ***Linalool: -***

It refers to 2 enantiomers (opposite or mirror image) of naturally occurring mono-terpene found in flowers & plants of many spices; it has a role plant metabolite, a volatile oil component, an anti-microbial agent, a fragrance agent, it is present in sweet basil, lavender, laurel, citrus fruits, cinnamon, rosewood, birch tree, tea tree oil etc. It is anti-anxiety, anti-depressant, sedative, anti-inflammatory, anti-epileptic, increase immunity. It is under research & its absorption, metabolism is not known.

- ***Cineole: -***

It is mono-terpene ether present in essential oils & used in fragrance, flavoring, medicines, cough drops, personal care products, used as expectorant, anti-septic. It is main constituent of eucalyptus oil; it is colourless, oil, slightly soluble in water. It has camphor like odour & pungent spicy cooling taste; it is also called as eucalyptol; it is anti-inflammatory, anti-viral, antioxidant, anti-spasmodic, increase cerebral blood flow, anti-fungal, immune-regulator, helpful in sinusitis, asthma, acute & chronic bronchitis, sore throat, laryngitis, herpes simplex, acne, measles, chicken pox, ulcers, wounds, boils cuts, burns; it is mucolytic, analgesic, clears the airway. It is present in sweet basil oil, common sage, bay leaves, camphor laurel, tea tree, worm-hood, moonwort, rosemary, thyme oil, cannabis sativa. Its absorption & metabolism is not known.

- ***Methyl cinnamate: -***

Methyl cinnamate is the methyl ester of cinnamic acid and is a white or transparent solid with a strong, aromatic odor. It is found naturally in a variety of plants, including in fruits, like strawberry, and some culinary spices, such as Sichuan pepper and some varieties of basil. Methyl cinnamate is used in the flavor and perfume industries.

- ***Cubenol: -***

Cubenol belongs to the family of Sesquiterpenes. These are terpenes with three consecutive isoprene units. Cubenol belongs to the class of organic compounds known as sesquiterpenoids. These are terpenes with three consecutive isoprene units. Cubenol is an extremely weak basic (essentially neutral) compound (based on its pKa).

- ***Amorphene: -***

(-)-alpha-amorphene is a member of the cadinene family of sesquiterpenes having a 4,7-dimethyl-1-(propan-2-yl)-1,2,4a,5,6,8a-hexahydronaphthalene skeleton with 1S,4aR,8aS-stereochemistry. It is isolated from the essential oils of several plant species. It has a role as a plant metabolite. It is a cadinene and a polycyclic olefin.

- ***Muurolene: -***

It is a sesquiterpene & a carbo-bicyclic compound; it is mainly of two types alpha & gamma, both are similarly; both are neuro-protective, anti-nociceptive; it is also present in ptychopetalum olaciodes. Gamma-muurolene is a sesquiterpene that is 1,2,3,4,4a,5,6,8a-octahydronaphthalene which is substituted at positions 1, 4 and 7 respectively by isopropyl, methylene and methyl groups (the 1S,4aS,8aR-diastereoisomer). It is a sesquiterpene, a carbobicyclic compound and a member of octahydronaphthalenes.

- ***Cis-muurola-4(14),5-diene: -***

Cis-muurola-4(14),5-diene is a carbobicyclic compound that is 1,2,3,4,4a,5,6,7-octahydronaphthalene which is substituted at positions 1, 4, and 7 by a propan-2-yl, methyl and methylidene groups, respectively (the 1R,4R,4aS-diastereoisomer). It is a sesquiterpene and a carbobicyclic compound.

- ***Alpha-copaene: -***

Alpha-copaene is a sesquiterpene that is tricyclo[4.4.0.0(2,7)]dec-3-ene bearing an isopropyl substituent at position 8 and two methyl substituents at positions 1 and 3 (the 1S,6S,7S,8S-diastereomer). It is a sesquiterpene and a bridged compound.

- ***Beta-copaene: -***

Beta-copaene, also known as β-copaene, is a member of the class of compounds known as sesquiterpenoids. Sesquiterpenoids are terpenes with three consecutive isoprene units. Beta-copaene can be found in a number of food items such as peppermint, common sage, corn, and star anise, which makes beta-copaene a potential biomarker for the consumption of these food products. Copaene, or more precisely, α-copaene, is the common (or trivial) chemical name of an oily liquid hydrocarbon that is found in a number of essential oil-producing plants. The name is derived from that of the resin-producing tropical copaiba tree, Copaifera langsdorfii, from which the compound was first isolated in 1914. Its structure, including the chirality, was determined in 1963. The double-bond isomer with an exocyclic-methylene group, β-copaene, was first reported in 1967.

- ***Beta-cubebene: -***

Beta-cubebene, also known as (-)-B-cubebene, is a member of the class of compounds known as sesquiterpenoids. Sesquiterpenoids are terpenes with three consecutive isoprene units. Beta-cubebene is a citrus and fruity tasting compound and can be found in a number of food items such as sweet basil, roman camomile, pot marjoram, and sweet bay, which makes beta-cubebene a potential biomarker for the consumption of these food products. Beta-cubebene can be found primarily in saliva. Piper cubeba, cubeb or tailed pepper is a plant in genus Piper, cultivated for its fruit and essential oil. It is mostly grown in Java and Sumatra, hence sometimes called Java pepper. The fruits are gathered before they are ripe, and carefully dried. Commercial cubebs consist of the dried berries, similar in appearance to black pepper, but with stalks attached – the "tails" in "tailed pepper". The dried pericarp is wrinkled, and its color ranges from grayish brown to black. The seed is hard, white and oily. The odor of cubebs is described as agreeable and aromatic and the taste as pungent, acrid, slightly bitter and persistent. It has been described as tasting like allspice, or like a cross between allspice and black pepper.

- ***Chavicol: -***

Chavicol, also known as p-allylphenol or alpha -propylene, belongs to the class of organic compounds known as 1-hydroxy-2-unsubstituted benzenoids. These are phenols that are unsubstituted at the 2-position. Chavicol is an extremely weak basic (essentially neutral) compound (based on its pKa). Chavicol is a medicinal and phenolic tasting compound. Chavicol is found, on average, in the highest concentration within a few different foods, such as cloves, sweet marjoram, and sweet basils and in a lower concentration in pineapples. Chavicol has also been detected, but not quantified in, several different foods,

such as allspices, chinese cinnamons, fats and oils, and gingers. This could make chavicol a potential biomarker for the consumption of these foods.

- ***Iso carveol dehydro: -***

(-)-Isodihydrocarveol is the (1R,2R,4S)-stereoisomer of dihydrocarveol. It is an enantiomer of a (+)-isodihydrocarveol.

- ***Terpinene: -***

Terpinene are group of isomeric hydrocarbons & classified as monoterpenes; Alfa terpinene is isolated from cardamom & marjoram oil & from other natural sources, but beta terpinene is made artificially (compounding).

Natural sources of it are cuminum cyminum, melalenca alternifolia, cannabis, apples, tea, cumin, nutmeg, rosemary etc. It has a pleasant aroma & flavour; it is used in manufacturing soaps, perfumes, lotions, insect repellent; it reduces anxiety because it is sedative, it is anticancer, antioxidant. Terpineols are monocyclic monoterpene tertiary alcohols which are naturally present in plant species. There are five common isomers of terpineols, alpha-, beta-, gamma-, delta- and terpinen-4-ol, of which α-terpineol and its isomer terpinen-4-ol are the most common terpineols found in nature. α-Terpineol plays an important role in the industrial field. It has a pleasant odor similar to lilacs and it is a common ingredient in perfumes, cosmetics, and aromatic scents. In addition, α-terpineol attracts a great interest as it has a wide range of biological applications as an antioxidant, anticancer, anticonvulsant, antiulcer, antihypertensive, anti-nociceptive compound. It is also used to enhance skin penetration, and also has insecticidal properties.

- ***Terpin-4-ol: -***

It is also known as 4-terpineol is a terpineol that is 1-menthene carrying a hydroxy substituent at position 4. It has a role as a plant metabolite, an antibacterial agent, an antioxidant, an anti-inflammatory agent, an antiparasitic agent, an antineoplastic agent, an apoptosis inducer and a volatile oil component. It is a terpineol and a tertiary alcohol.

- ***Terpinolene: -***

It is among isomeric hydrocarbon group; it a monoterpene; it is a volatile oil component, not soluble in water; it is sedative, insect repellent; it is used in making plastics & resins; it is found in all spices; it is a flavouring agent.

It is present in citrus, mentha, juniperus, myristica, parnip oil, pine oil, tea tree oil, orange, marjoram etc.

It is antioxidant, anticancer, sedative (when inhaled) reduces anxiety, helpful in insomnia, panic attack, anti-bacterial, anti-fungal; it is used in making of soap, perfumes, lotions, insect repellent.

- ***Terpineol: -***

It is a monoterpene alcohol that is isolated from a variety of sources like pine oil, petit-grain oil, marjoram oil, cajuput oil. Alpha terpineol is most commonly present in trees, though there are 5 isomers of it, Alpha, beta, gamma, delta & terpinen-4-ol; it has pleasant odour & commonly used in perfumes, cosmetics, aromatics, scents etc; It is antioxidant, anticancer, anti-convulsant, anti-hypertensive, anti-nociceptive; it enhances skin penetration, it is insecticidal; it is also present in flowers, of narcissus, & freesia, & in herbs like marjoram, oregano, rosemary, lemon peel oil. Terpineols are monocyclic monoterpene tertiary alcohols which are naturally present in plant species. There are five common isomers of terpineols, alpha-, beta-, gamma-, delta- and terpinen-4-ol, of which α-terpineol and its isomer terpinen-4-ol are the most common terpineols found in nature. α-Terpineol plays an important role in the industrial field. It has a pleasant odor similar to lilacs and it is a common ingredient in perfumes, cosmetics, and aromatic scents. In addition, α-terpineol attracts a great interest as it has a wide range of biological applications as an antioxidant, anticancer, anticonvulsant, antiulcer, antihypertensive, anti-nociceptive compound. It is also used to enhance skin penetration, and also has insecticidal properties.

- ***Borneol: -***

It is a bicyclic organic compound and a terpene derivative; it is naturally found in two forms enantiomers (opposite or mirror image) as d & I. It aids the digestive system by stimulating the production of gastric juices, tone of heart, improves circulation; treats bronchitis, cough & cold; can relieve pain cause by rheumatic diseases & sprains; reduces swelling, relives stress. It is under research.

- ***Natural camphor: -***

Natural camphor is derived from the sap of an evergreen tree the camphor laurel, other laurels, and rosemary, the common kitchen herb. Synthetic camphor is derived from the sap (turpentine) of evergreen trees in the pine family. Camphor (topical) suggested uses include treating pain, warts, cold sores, hemorrhoids, osteoarthritis, anti-itch, to increase local blood flow, and as a counterirritant. Camphor is an FDA-approved topical antitussive (anti-cough). Camphor is an FDA-approved topical analgesic and anesthetic used to relieve pain.

- ***Ocimene: -***

It is a monoterpene & among group of isomeric hydrocarbons; it is often found naturally as mixture of various forms (in oil); it has pleasant odour sweet & herbaceous; it is used in perfumes making; it is insoluble in water, but soluble in common organic solvents; it is anti-fungal, anti-bacterial, insecticidal; beta-ocimene that consists of octa-1,3,6-triene bearing two methyl substituents at positions 3 and 7 (the 3E-isomer). It has a role as a plant metabolite. (E)-beta-ocimene is a beta-ocimene that consists of octa-1,3,6-triene bearing two methyl substituents at positions 3 and 7 (the 3E-isomer). It has a role as a plant metabolite.

- ***Limonene: -***

It is a cyclic monoterpene & is the major component in the oil of citrus fruit peels; it is soluble in water; it has a pleasant aroma.

Main sources of limonene: -

It is present in orange, orange peel, grapes, lemon, lime, mandarins & marjoram.

Basic pharmacokinetics of limonene (based on human intake in natural food products): -

Limonene is completely absorbed when taken orally; it can be absorbed by inhalation up to 70%; it can be also absorbed by skin; it is distributed throughout the body & fats tissues; it is metabolized in liver & excreted in urine.

Basic clinical pharmacology of limonene: -

it is anti-inflammatory, antioxidant, anti-stress, prevents diseases, it is a natural insect repellant, it is used as an additive & flavouring agent, it is used in shampoo, soaps, perfumes detergent making, also used in laundry, cosmetics, air fresher etc. It is also available in concentrated supplement in capsules & liquid form; it is anti-inflammatory, antioxidant, anti-cancer, heals heart disease, strengthens the heart, reduces stress, anxiety and improves digestion.

- ***Myrcene: -***

It is monoterpene & is olefinic natural organic hydrocarbon; its aroma is earthy, fruity & clove like; it is pungent, it synergizes activity of terpenes & it has a role as a plant metabolite etc.

It is present in wild thyme leaves, cannabis, hops, lemon grass, mango, myrica, verbena, cardamom, West Indian bay tree, marjoram, houttuynia, basil etc.

It is useful in treating diabetes, diarrhea, dysentery, blood pressure, reduces pain, increases transdermal absorption, improves glucose tolerance, good for osteoarthritis, also used as flavouring agent, perfume making etc; it crosses blood brain barrier & increases the transport of cannabinoids in the brain,), it is a significant analgesic. It is under research & its absorption, metabolism is not known. It is anti-anxiety, anti-depressant, sedative, anti-inflammatory, anti-epileptic, increase immunity.

- ***Pinene***

It is a bicyclic monoterpene chemical compound. There are two structural isomers of pinene found in nature: α-pinene and β-pinene. As the name suggests, both forms are important constituents of pine resin; they are also found in the resins of many other conifers, pine tree, maktur tree oil, lime fruit peel, as well as in non-coniferous plants such as camphorweed (*Heterotheca*) and big sagebrush (*Artemisia tridentata*). It is anti-inflammatory, bronchodilator, antianxiety, anti-pain etc.

- ***Sabinene: -***

It is a natural thujene bicyclic monoterpene; it is also called as Thujene, sabanene etc; it has woody & spicy smell, it is also used in perfume making & as a flavouring agent in eatables; it is mainly present in black pepper, carrot, seed oil, tea tree oil, nutmeg oil, bay tree, horse wood tree, Norway spruce, marjoram etc; it is strong anti-bacterial that also gram positive bacterias, and is anti-fungal, antiseptic, anti-helicobacter, anti-ulcer, anti-inflammatory, antioxidant, inhibits nitric oxide.

- ***Thujene: -***

It is referred as alpha-thujene; it is a monoterpene found in many essential oils of plants; it is similar to sabinene; it is present in marjoram oil, boswellia serrata oil, eucalyptus oil, it has a pungent taste, green herbal woody smell, it is yellowish transparent; it is anti-inflammatory, anti-arthritis, antimicrobial, insecticide.

- ***Thujone: -***

It is a ketone & mono-terpene that occurs naturally in two forms alpha & beta; it has a menthol odour; it acts on GABA as an antagonist (opposite to the effects of alcohol); it is used in perfumes; it is present in thyme oil, arborvitae, nootka cypress, oregano, common sage, tansy, worm-wood. In high & toxic dose it is convulsant & neuro-toxic. Its absorption, metabolism is not known & is under research.

- ***Eucalyptol: -***

Eucalyptol is a natural organic compound that is a colorless liquid. It is cyclic ether and a monoterpenoid. It is present in eucalyptus oil, wormwood, rosemary, lime peel oil etc; it is a strong anti-inflammatory, relaxant, antitussive remove phlegm.

- ***Humulene: -***

It is also known as a-caryophyllene; it is a monocyclic sesquiterpene; it is present in humulus lupulus oil (hops) & salvia officinalis (common sage, culinary sage), lindera strychrifolia, ginseng, ginger, mentha spicata etc; it is often present with Beta-caryophyllene; It has woody aroma; it is anti-inflammatory, anti-arthritis, anti-fibromyalgia etc.

- ***Elemene: -***

Beta-elemene, also known as B-elemen or 2,4-diisopropenyl-1-methyl-1-vinylcyclohexane, is a member of the class of compounds known as elemane sesquiterpenoids. Elemane sesquiterpenoids are sesquiterpenoids with a structure based on the elemane skeleton. Elemane is a monocyclic compound consisting of a cyclohexane ring substituted with a methyl group.

- ***Germacrene d: -***

It is a volatile sesquiterpene & amongst essential oils; it is found in many species & is of two prominent molecules Germacrene A & D; D is present mainly in lamium purpureum, clausena auisata, basil, clary sage etc.

- ***Farnesene: -***

The term farnsene refers to a set of six closely related chemical compounds which all are sesquiterpenes; it is found in alpha & beta form, both are similar with little difference but alpha is most common & found in apple coats, perilla oil; it is anti-anxiety, anti-spasmodic, calming, sedative, muscles relaxant, anti-inflammatory, anti-fungal, anti-bacterial; it is used in cosmetics, perfumes etc. α-Farnesene and β-farnesene are isomers, differing by the location of one double bond. Beta-Farnesene, also known as (Z)-b-farnesene or b-cis-farnesene, belongs to the class of organic compounds known as sesquiterpenoids. These are terpenes with three consecutive isoprene units; beta-Farnesene is possibly neutral.

- ***Cadinene:-***

Cadinene is the trivial chemical that occurs in a wide variety of essential oil-producing plants. The name is derived from that of the Cade juniper (Juniperus oxycedrus L.), the wood of which yields oil from which cadinene isomers were first isolated. Chemically, the cadinenes are bicyclic sesquiterpenes. It is anti-inflammatory & increase energy level; b-cadinene usually predominating, occur in several essential oils, especies ylang-ylang, citronella and cade oil from Juniper subspecies Cadinene isomers are used as a flavouring agent and/or flavour modifier. beta-Cadinene is found in many foods, some of which are ginger, common oregano, sweet basil, and common thyme.

- ***Phellandrene: -***

In Marjoram alpha & beta phellandrene are present; it is a pair of organic compound that have a similar molecular structure & similar chemical properties; both alpha & beta are cyclic monoterpenes & are double-bond isomer. In alpha both double bond are endocyclic & in beta one double bond is exocyclic; both are soluble in water; they have a pleasant aroma & peppery taste.

Alpha is potential immune stimulator, anti-fungal, anti-inflammatory, anti-cancer, anti-pain, develop natural killer (NK) in the body, boost immune system; beta is anti-microbial, anti-fungal, antioxidant; both are believed to be excreted in stools,

Beta is present in oil of following bitter fennel, elemi, ginger-grass, ridolfia segetum & alpha is present in oil of cinnamon, dill, turmeric, ceylon etc.

- ***Carvacrol: -***

It is a mono-terpenoid phenol; it has a pungent, warm odour of oregano, it is also called as cymophenol. It is present in thyme oil, oregano, pepperwort, wild bergamot. It helps in curing candida infection & yeast infections; it is anti-cancer, anti-bacterial, antioxidant, anti-inflammatory, reduces blood pressure, improves gut health; heals wounds etc. it is an active principle of oregano oil. Its absorption, metabolism in human is yet not known.

- ***Carvone: -***

It gives black seeds a special taste & odour; it is a volatile terpenoid. Its absorption, metabolism is not known.

Main sources of carvone: -

Black seed, dill seed, orange peel oil, spearmint, mandarin.

Basic clinical pharmacology of carvone: -

It is a decongestant, diuretic, anti-viral, anti tumour, carminative, cardio-protective, stomachic, prevents bronchitis, asthma, cough, laryngitis, sore throat, colicky pain, urinary infection, reduces and relief gastric spasm.

- ***Borneol: -***

It is a bicyclic organic compound and a terpene derivative; it is naturally found in two forms enantiomers (opposite or mirror image) as d & I. It aids the digestive system by stimulating the production of gastric juices, tone of heart, improves circulation; treats bronchitis, cough & cold; can relieve pain cause by rheumatic diseases & sprains; reduces swelling, relives stress. It is under research.

- ***Geraniol: -***

It is a mono-terpene found in many essential oils of fruits & vegetables, herbs like rose oil, citronella, lemon grass, lavender, thyme oil etc. it is emitted from flowers of many spices of plants & used in food, fragrance & cosmetic products; it is microbial, anti-inflammatory, antioxidant, anti-cancer, neuro-protective, anti-cancer, anti tumour. It is colourless or little yellowish, slightly water soluble & has a sweet odour rose oil like; its absorption, metabolism is not known.

- ***Thymol: -***

It is a natural mono-terpenoid phenol mostly present in thyme plant; it has pleasant aromatic odour, it is anti-hook worm.

Main sources of thymol: -

Thyme oil, eye bright plant (Euphrasia rostkoviana), monarda didyma & origanum compactum.

Basic pharmacokinetics of thymol (based on human intake in natural food products): -

It is readily absorbed in intestines on oral administration; it is essentially excreted in urine within the first 24 hours after absorption.

Basic clinical pharmacology of thymol: -

It reliefs headache, diarrhea; it is anti-cancer, anti-septic, anti-inflammatory, antioxidant, anti-fungal, anti-spasmodic, anti-bacterial, prevent free radical, cardio vascular disease, it is analgesic, reduces lipids, treat pain & neurological diseases.

- ***Neryl acetate: -***

It is also called as Geranyl acetate, also known as neryl ethanoate or fema 2509, belongs to the class of organic compounds known as fatty alcohol esters. These are ester derivatives of a fatty alcohol. Geranyl acetate is a very hydrophobic molecule, practically insoluble (in water), and relatively neutral. Geranyl acetate is a potentially toxic compound.

- ***Bergamotene: -***

Bergamotenes are a group of isomeric chemical compounds with the molecular formula $C_{15}H_{24}$. The bergamotenes are found in a variety of plants, particularly in their essential oils. There are two structural isomers, α-bergamotene and β-bergamotene, which differ only by the location of a double bond. Both of these isomers have stereoisomers, the most common of which are known as the *cis* and *trans*-isomers (or endo- and exo-isomers) α-Bergamotene is found in the oils of carrot, bergamotene, bergamot, lime, citron, cottonseed & kumquat.

- ***Cadinol: -***

Cadinol is also known as alpha-cadinol. Cadinol is practically insoluble (in water) and an extremely weak basic (essentially neutral) compound (based on its pKa). Cadinol can be found in spearmint, which makes cadinol a potential biomarker for the consumption of this food product. Cadinol is any of several organic compounds with formula C 15H 26O, especially: α-cadinol δ-cadinol (torreyol, sesquigoyol, pilgerol, albicaulol) T-cadinol.

- ***Selinene: -***

It is a group of isomeric chemical compounds amongst sesquiterpenes; it is found in 2 types alpha & beta; It is present in celery seed oil, marjoram oil etc; it is anti-inflammatory, antioxidant, anti-gouts (increase uric acid). Alpha-selinene is an isomer of selinene where the double bond in the octahydronaphthalene ring system is endocyclic (2R,4aR,8aR)-configuration.. It has a role as a plant metabolite. It is a selinene and a member of octahydronaphthalenes.

- ***Ursolic acid (UA): -***

It is pentacyclic triterpenoid; it is widely present in peels of fruit, herbs like rosemary, thyme, vegetables, basil etc. It is anti-inflammatory, anti-oxidant, anti-apoptotic, anticancer. UA-associated compounds include oleanolic acid, betulinic acid, uvaol and α- and β-amyrin; UA has the molecular formula $C_{30}H_{48}O_3$, a molecular weight of 456.70032 g/mol and a melting point of 283–285°C. UA can be dissolved in methanol, pyridine and acetone, but is insoluble in water and petroleum ether; UA and its derivatives exhibit potent biological and pharmaceutical effects. The anti-inflammatory effect of UA was linked to attenuation of production of proinflammatory cytokines including tumor necrosis factor α, interleukin; U A was associated with suppression of the nuclear factor-κB (NF-κβ) pathway, inhibition of expression of cyclooxygenase-2 (COX-2) and nitric oxide synthase and the reduction of perhydrides including nitric oxide and hydrogen peroxide.

- ***Caffeic acid: -***

It is 3-4 dihydroxycinnamic acid; it is a type of polyphenol; It is an organic compound that is classified as hydroxycinnamic acid; it is present in all plants; it is a strong antioxidant, anticancer, beneficial in dementia & anti-inflammatory, antiviral, boosts athlete performance, reduces blood glucose in diabetes, and reduces aging. It is present coffee, turmeric, thyme, cabbage, apple, mushroom, olive oil etc. Every less is known about it yet.

- ***Rosmarinic acid: -***

It is an ester of caffeic acid & 3, 4 dihydroxyphenyllactic acid; it is commonly found in Boraginaceae family plants; it is of red-orange colour; it is water soluble; it is polyphenolic in nature.

Main sources of rosmarinic acid: -

It is present in fresh & dried thyme, sage, dried marjoram, dried peppermint, dried & fresh rosemary, and dried sweet basil.

Basic pharmacokinetics of rosmarinic acid (based on human intake in natural food products): -

Its absorption, metabolism & excretion are yet not known & are under research. It is well absorbed in gastrointestinal tract & through skin.

Basic clinical pharmacology of rosmarinic acid: -

It is anti-inflammatory, analgesic, anti-pyretic, platelet inhibitor; it blocks the synthesis of prostaglandin.

- ***Apigenin: -***

It is a natural flavonoid compound found in many fruits & vegetables serves multiple physiological functions.

Main sources of apigenin: -

It is present in onion, oranges, wheat, tea, grapes, parsley, thyme.

Basic pharmacokinetics of apigenin (based on human intake in natural food products): -

Its absorption, metabolism & excretion are yet not known & are under research.

Basic clinical pharmacology of apigenin: -

It calms the nerves, provides antioxidant effects, prevents & helps the body to fight cancer; it is anti-obesity; neuro-protective, help mood & brain function; reduces cortisol, blood sugar; improves bone, heart & skin health; promotes sleep. It is also anti-bacterial, anti-viral; reduces blood pressure.

- ***Stigmasterol: -***

It is among unsaturated phytosterol; it maintains the structure & physiology of cell membrane; it reduces LDL & cholesterol, reduces risk of heart diseases, it prevents atherosclerosis.

Main sources of stigmasterol: -

Soybean, calabar bean, rape seed, legumes, nuts, milk, seeds, grape seed oil etc.

- ***Citronellol: -***

It is a natural terpenoid; it has special rose like smell; it is a constituent of essential oils like rose oil, geranium, neroli, chamomile, basil, lemon grass & lavender oil. Its absorption & metabolism is not known.

Basic clinical pharmacology of citronellol: -

It is anti-fungal, anti-microbial, anti-cancer, anti-inflammatory, reduces blood pressure, analgesic, good for cardio vascular diseases, anti-spasmodic, nourishes hair, increases digestion, good for complexion, boost immunity.

- ***Citral: -***

It is present in ginger & reported to be bronchodilator & reduces hyper-activity in lungs. Citral is a main component of citrus fruit's peel oil. It is especially found in orange peel.

- ***Linalyl acetate***

Linalyl acetate is a naturally occurring phytochemical found in many flowers and spice plants. It is one of the principal components of the essential oils of bergamot and lavender. Chemically, it is the acetate ester of linalool, and the two often occur in conjunction. It is anti-inflammatory, antioxidant, helps in controlling blood pressure & antimicrobial.

- ***Tau-cadinol: -***

Tau-cadinol is a cadinane sesquiterpenoid that is cadin-4-ene carrying a hydroxy substituent at position 10. It has a role as a volatile oil component and a plant metabolite. It is a cadinane sesquiterpenoid, a carbobicyclic compound, a tertiary alcohol and a member of octahydronaphthalenes.

- ***1.8-cineole: -***

1.8-cineole is a natural monoterpene, also known as eucalyptol. It is a major compound of many plant essential oils, mainly extracted from Eucalyptus globulus oil. As an isolated compound, 1.8-cineole is known for its mucolytic and spasmolytic action on the respiratory tract, with proven clinical efficacy. 1.8-cineole has also shown therapeutic benefits in inflammatory airway diseases, such as asthma and chronic obstructive pulmonary disease (COPD).

- ***Bornyl acetate: -***

Bornyl acetate is a chemical compound. Its molecular formula is $C_{12}H_{20}O_2$ and its molecular weight is 196.29 g/mol. It is the acetate ester of borneol. It is used as a food additive, flavouring agent, and odour agent. It is a component of the essential oil from pine needles (from the family Pinaceae) and primarily responsible for its odour.

- ***Beta-caryophyllene: -***

Beta-caryophyllene is a pale yellow oily liquid with an odor midway between odor of cloves and turpentine. It is usually found as a mixture with isocaryophyllene (the *cis* double bond isomer) and α-humulene (obsolete name: α-caryophyllene), a ring-opened isomer. Caryophyllene is notable for having a cyclobutane ring, as well as a *trans*-double bond in a 9-membered ring, both rarities in nature.

- ***Bergamotene: -***

Bergamotenes are a group of isomeric chemical compounds with the molecular formula $C_{15}H_{24}$. The bergamotenes are found in a variety of plants, particularly in their essential oils. There are two structural isomers, α-bergamotene and β-bergamotene, which differ only by the location of a double bond. Both of these isomers have stereoisomers, the most common of which are known as the *cis* and *trans*-isomers (or endo- and exo-isomers) α-Bergamotene is found in the oils of carrot, bergamotene, bergamot, lime, citron, cottonseed & kumquat.

- ***Germacrene B: -***

Germacrene B, also known as germacratriene, belongs to the class of organic compounds known as germacrane sesquiterpenoids. These are sesquiterpenoids having the germacrane skeleton, with a structure characterized by a cyclodecane ring substituted with an isopropyl and two methyl groups. Thus,

germacrene b is considered to be an isoprenoid lipid molecule. Germacrene B is a very hydrophobic molecule, practically insoluble (in water), and relatively neutral.

- ***Guaiene: -***

Alpha-guaiene is a carbobicyclic compound and sesquiterpene that is 1,2,3,4,5,6,7,8-octahydroazulene which is substituted by methyl groups at positions 1 and 4 and by a (prop-1-en-2-yl group at position 7 (the 1S,4S,7R enantiomer). It has a role as a volatile oil component and a plant metabolite. It is a carbobicyclic compound and a sesquiterpene. Beta-Guaiene is found in herbs and spices. Beta-Guaiene is a flavouring ingredient. Beta-Guaiene is a constituent of sweet flag oil.

- ***Natural menthol: -***

The main form of menthol occurring in nature is (−)-menthol, which is assigned the (1*R*,2*S*,5*R*) configuration. Menthol has local anesthetic and counterirritant qualities, and it is widely used to relieve minor throat irritation. Menthol also acts as a weak kappa opioid receptor agonist. (+)-neoisomenthol, also known as cis-1,3,cis-1,4-menthol or iso-neomenthol, is a member of the class of compounds known as menthane monoterpenoids. Menthane monoterpenoids are monoterpenoids with a structure based on the o-, m-, or p-menthane backbone. P-menthane consists of the cyclohexane ring with a methyl group and a (2-methyl)-propyl group at the 1 and 4 ring position, respectively. The o- and m-menthanes are much rarer, and presumably arise by alkyl migration of p-menthanes. Thus, (+)-neoisomenthol is considered to be an isoprenoid lipid molecule (+)-neoisomenthol is practically insoluble (in water) and an extremely weak acidic compound (based on its pKa). Within the cell, (+)-neoisomenthol is primarily located in the membrane (predicted from logP).

- ***Pulegone: -***

Pulegone is a naturally occurring organic compound obtained from the essential oils of a variety of plants such as Nepeta cataria (catnip), Mentha piperita, and pennyroyal. It is classified as a monoterpene. Pulegone is a clear colorless oily liquid and has a pleasant odor similar to pennyroyal, peppermint and camphor.

- ***Safrole: -***

Safrole is an organic compound with the formula $CH_2O_2C_6H_3CH_2CH=CH_2$. It is a colorless oily liquid, although impure samples can appear yellow. A member of the phenylpropanoid family of natural products, it is found in sassafras plants among others. Small amounts are found in a wide variety of plants, where it functions as a natural antifeedant. *Ocotea pretiosa* which grows in Brazil, and *Sassafras albidum*, which grows in eastern North America, are the main natural sources of safrole. It has a characteristic "sweet-shop" aroma. It is a precursor in the synthesis of the insecticide synergist piperonyl butoxide, the fragrance piperonal via isosafrole, and the empathogenic/entactogenic drug MDMA.

- ***Menthone: -***

Menthone is a monoterpene with a minty flavor that occurs naturally in a number of essential oils. Menthone (or (2*S*,5*R*)-*trans*-2-isopropyl-5-methylcyclohexanone), shown at right, is the most abundant in nature of the four possible stereoisomers. It is structurally related to menthol, which has a secondary alcohol in place of the carbonyl. Menthone is used in flavoring, perfume and cosmetics for its characteristic aromatic and minty odor.

- ***Pulegone: -***

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- ***Carveol: -***

Carveol is a limonene monoterpenoid that is cyclohex-2-en-1-ol substituted by a methyl group at position 2 and a prop-1-en-2-yl group at position 5. It has a role as a volatile oil component and a plant metabolite. Carveol is found in caraway. Carveol is present in oil of grapefruit (Citrus paradisi), mandarin (Citrus reticulata), blackcurrant berries, celery, black tea, dill, caraway seeds and lamb's lettuce. Carveol is a flavouring agent.

- ***Verbenone: -***

Verbenone is a natural organic compound classified as a terpene that is found naturally in a variety of plants. The chemical has a pleasant characteristic odor. Besides being a natural constituent of plants, it and its analogs are insect pheromones. In particular, verbenone when formulated in a long-lasting matrix has an important role in the control of bark beetles such as the mountain pine beetle and the Southern pine bark beetle.

- ***Fenchone: -***

Fenchone is an organic compound classified as a monoterpenoid and a ketone. It is a colorless oily liquid. It has a structure and an odor similar to those of camphor. Fenchone is a constituent of absinthe and the essential oil of fennel. Fenchone is used as a flavor in foods and in perfumery.

- ***Luteolin: -***

Luteolin is a common flavonoid abundantly present in several plant products, including broccoli, pepper, thyme, and celery. Studies have shown that luteolin possesses beneficial neuroprotective effects both in vitro and in vivo. It also has antioxidant and immunomodulatory properties.

- ***Citronellic acid: -***

Citronellic acid is a monounsaturated fatty acid that is oct-6-enoic acid carrying methyl groups at positions 3 and 7. It has a role as a plant metabolite and a flavouring agent. It is a monoterpenoid, a medium-chain fatty acid and a monounsaturated fatty acid. It derives from a citronellal.

- ***Cinnamic acid: -***

Cinnamic acid is an organic compound with the formula $C_6H_5CH=CHCOOH$. It is a white crystalline compound that is slightly soluble in water, and freely soluble in many organic solvents. Classified as an unsaturated carboxylic acid, it occurs naturally in a number of plants.

- ***Aliphatic aldehyde: -***

An aliphatic compound is an organic compound containing carbon and hydrogen joined together in straight chains, branched chains, or non-aromatic rings. It is one of two broad classes of hydrocarbons, the other being aromatic compounds. Aliphatic compounds are also known as aliphatic hydrocarbons or eliphatic compounds & an aldehyde is a compound containing a functional group with the structure −CHO, consisting of a carbonyl center (a carbon double-bonded to oxygen) with the carbon atom also bonded to hydrogen and to an R group.

- ***Perillaldehyde: -***

Perillaldehyde, or perilla aldehyde, is a natural organic compound found most abundantly in the perennial herb perilla, but also in a wide variety of other plants and essential oils. It is a monoterpenoid containing an aldehyde functional group.

- ***Potassium: -***

It is a mineral with symbol K & atomic number 19, it is an essential mineral which body cannot prepare; it is necessary for heart, kidney & other organs to function, its low level in body is called as hypokalemia & high level is called as hyperkalemia; it is mostly present inside the cells (intracellular); normal blood range is 3.5 to 5.0 milli equivalents per/liter (mEq/L).

Main sources of potassium: -

Potassium is naturally present in banana, orange, dates, raisin, broccoli, milk, chicken, sweet potato, pumpkin, spinach, watermelon, coconut water, white & black beans, potato, dried apricot, beetroot, pomegranate, almond, quince etc.

Basic pharmacokinetics of potassium (bases on human intake in natural food products): -

It is absorbed in small intestines by passive diffusion; it is stored mostly inside the cell, little in liver, bones & red blood cells. 80 to 90% potassium is excreted in urine & 5 to 20% is excreted in stools, sweat.

Basic clinical pharmacology of potassium: -

It is a mineral belongs to electrolytes of the body; it conducts electrical impulses throughout the body & assists blood pressure, normal water balance, muscle contraction, nerves impulse, digestion, heart rhythm, maintain pH balance. It is not produced in our body so we need to consume it through eating; Kidneys maintain normal level of it in the body by excreting excessive amount of it in urine or reabsorb it if the amount is less in the body so that the body may reuse it. Its deficiency may cause weakness, low blood pressure, constipation, nausea, vomiting etc.

Its normal amount in body keeps blood pressure normal; water balance in body normal; prevents heart disease, stroke, osteoporosis, kidney stone etc.

- ***Carbohydrate: -***

It is a macronutrient needed by the body, the body receives 4 calories per 1 gram of it; carbohydrates includes sugar, glycogen, starch, dextrin, fiber & cellulose that contain only oxygen, carbon & hydrogen. It is classified in simple & complex; simple carbs are sugar & complex carbs are fiber & starch which take longer to digest. It is basic source of energy for our body.

Main sources of carbohydrates: -

It is present in watermelon (little), potato, sweet potato, bread, oats, butter, white rice, whole grain rice, pasta, lentils, banana, pineapple, quince etc.

Basic pharmacokinetic of carbohydrate (based on human intake in natural food products): -

Its digestion begins in mouth; salivary glands releases saliva & salivary amylase (enzyme) which begins the process of breaking down the polysaccharides (carbohydrates) while chewing the food; now the chewed food bolus is passed in stomach through food pipe (esophagus); gastric juice like HCL, rennin etc & eaten material are churned to form chyme in the stomach; the chyme now is passed little by little down into duodenum, pancreatic amylase are released which break the polysaccharides down into disaccharide (chain of only sugars linked together); now the chyme passes to small intestine, in it enzymes called lactase, sucrase, maltase etc breakdown disaccharides into monosaccharide (single sugar) & absorbed in upper & lower intestines, through villi present in small intestine & send into liver through venous blood present into portal veins, as per bodies need it is releases in the blood stream & pancreas release insulin to use it as source of energy for the body, & extra is stored is converted into glycogen by liver & stored in liver & little is stored in muscles & tissues. Liver can reconverts glycogen in to sources of energy if body lacks for other source of energy, the undigested carbohydrates reaches the large intestine (colon) where it is partly broken down & digested by intestinal bacterias, the remains is excreted in stools.

Clinical pharmacology of carbohydrates: -

Carbohydrates are main sources of body energy, it helps brain, kidney, heart, muscles, central nervous system to function, it also regulates blood glucose, it acts on uses of protein as energy, breakdown of fatty acids & prevent ketosis. If we eat less carbohydrate it may lead to hypoglycemia, ketosis, frequent urination, fatigue, dizziness, headache, constipation, bad breath, dehydration etc.

Excessive intake of carbohydrates may lead to vascular disease, atherosclerosis (leads to narrowing of arteries, stroke, diabetes, obesity, fatty liver, blood pressure etc.

- ***Sodium: -***

Here we are learning natural sodium, its symbol is Na & atomic no. 11; it is not produced in the body we need to take it in food sources; it is an important & essential mineral on which our body functions; it regulates blood pressure, blood volume etc.

Main sources of sodium: -

Excessive intake of sodium should be avoided; It has very less amount of sodium; vegetables & fruits have less sodium in them which is good for the body. It is present in beans, meat, fish, chicken, chilli, bread, rolls, milk, celery, beetroot etc.

Basic pharmacokinetic of sodium (based on human intake in natural food products): -

It is absorbed in ileum by active sodium transport because it is impermeable & in jejunum absorption takes place via mediated active transport & depends on levels of water, bicarbonate, glucose, amino acids etc; its absorption plays an important role in the absorption of chloride, amino acids, glucose & water; similar mechanism are involved in the reabsorption of it in kidneys when its level in the body falls. It is excreted mainly in urine, little in sweat & stools. It is stores in bones & dissolved in various body fluids.

Basic clinical pharmacology of sodium: -

It is amongst the essential electrolyte within the body, it remains in extracellular fluid (outside the cell) mainly, it carries electrical charges within the body, kidney maintain its normal level in the body, normal level is 135-145 milli-equivalent per liter (mEq/L), it is not produce in the body, it acts on muscles contraction, nerve cells, regulates blood pressure, blood volume; it takes part in every function of the body mostly, its low level in body is called as hyponatremia, it is found more in older aged, kidney disease, heart disease, hospitalized patient, this condition may cause brain edema, low blood pressure, fatigue, tiredness etc; its high level in the body is called as hypernatremia may cause increase in blood pressure, thirst, confusion, muscle twitching or spasm, seizures, weakness, nausea, loss of appetite, swelling in body etc.

- ***Beta carotene: -***

It is an anti-oxidant that converts into vitamin A & plays a very important role in human health; it is responsible for the red, yellow, orange colouration in some fruits & vegetables. It promotes eye health & prevents eye diseases.

Main sources of beta carotene: -

It is present in pumpkin, carrot, sweet potato, dark leafy vegetables, apricot, red & yellow pepper, spinach, kale etc.

Basic pharmacokinetics of beta carotene (based on human intake in natural food products):

It is absorbed in intestine by passive diffusion & get convert into provitamin A in the presence of bile acids, the intestinal mucosa plays a key role in converting it into provitamin A. it is transported in blood plasma exclusively by lipoproteins. The complete absorption, metabolism & excretion in not known fully. It is stored in fats & liver.

Basic clinical pharmacology of beta carotene: -

It is anti-oxidant, reduces risk of lung cancer & promote lung health, reduces free radicals thus prevents cancer & heart disease, diabetes, promotes skin health, improves complexion, hair health, eye health, brain health; reduces pimple, acne & other skin problems.

- ***Vitamin A: -***

It is a fat soluble vitamin; it is group of unsaturated organic compound that includes retinol, retinal, retinoic acid & several provitamin A carotenoid. There are 2 types of vitamin A, 1) Vitamin A: - found in meat, poultry, fish & dairy products; 2) Provitamin A: - found in fruits, vegetables, plants; beta carotene is common type of provitamin A; it is an antioxidant, reduces wrinkles & repairs the skin damages; it is available in the market as tretinoin in tablets & creams to heal acne.

Main sources of vitamin A: -

It is present in watermelon, fish oil, carrot, green leafy vegetables, citrus fruit, sweet potato, spinach, kale, quince, pumpkin, grapes etc.

Basic pharmacokinetic of vitamin A (based on human intake in natural food products): -

It is absorbed in jejunum mainly, little through skin; metabolism is in liver & excreted in urine & stools, it is conjugated with glucuronic acid & then changed into retinal & retinoic acid; retinoic acid is excreted in stool, mainly. It is stored primarily as palmitate in Kupffer's cells of liver, normal adult liver stores sufficient amount of it which is enough for 2 years for the body, little is stored in kidneys, lungs, adrenal glands, fats, retina; it is excreted in urine & stools.

Clinical pharmacology of vitamin A: -

it is needed by the body for vision and maintains eye health speacially retina; it prevents night blindness; it helps in normal reproduction of cells thus prevents cancer; it is required for proper growth & development of embryo throughout the pregnancy period, it is good for skin, supports immune function; helps the heart, kidneys & lungs to work properly.

- ***Vitamin E: -***

It is fat soluble vitamin; it is a group of eight fat soluble compounds that includes four tocopherols & four tocotrienols.

Main sources of vitamin E: -

It is present in olive oil, almonds, cereals, wheat germ, sunflower oil, corn oil, soybean oil, peanuts, green leafy vegetables, pumpkin, grapes etc.

Basic pharmacokinetics of vitamin E (based on human intake in natural food products): -

It is absorbed in small intestines & metabolized in liver & distributed through lymphatic system & stored in fat droplets of adipose tissue cells; it is mainly excreted in stool, little in urine & through skin.

Basic clinical pharmacology of vitamin E: -

It prevents coronary heart disease, supports immune system, prevent inflammation, promotes eye health, lowers the risk of cancer; It is a powerful anti-oxidant thus reduces UV damage of skin, nourishes & protects the skin when applied on face; also promotes hair growth.

- ***Vitamin C: -***

It is also called as Ascorbic acid; it is an essential water soluble vitamin, very much needed by the body for many functions & absorption etc.

Main sources of vitamin C: -

It is present in watermelon, citrus fruit, broccoli, cauliflower, sprouts, capsicums, papaya, strawberries, spinach, green & red chillies, cabbage, leafy vegetables, tomato, cereals, quince, cucumber etc.

Basic pharmacokinetic of vitamin C (based on human intake in natural food products): -

It does not need to undergo digestion, 80 to 90% of it eaten is absorbed by intestine cell border by active transport & passive diffusion & through ion channels it enters the plasma via capillaries. It is very little stored in adrenal glands, pituitary gland, brain, eyes, ovaries, testes, liver, spleen, heart, kidneys, lungs, pancreas & muscles. All together body can store 5 grams of it & we need 200mg/day in order to maintain its normal level & uses, but old, disease person, smokers & alcoholic need more daily value. It is excreted in urine in the form of dehydroascorbic acid changed by liver & kidneys both, but unused vitamin C is excreted intact.

Basic clinical pharmacology of vitamin C: -

It prevent cough & cold, repairs tissue, acts as an enzyme for curtain neurotransmitter, important for immune function, it is a powerful antioxidant (donates electron to various enzymatic & non-enzymatic reactions); body prepares collagen with the help of vitamin c; it is also helpful in Alzheimer's, dementia, acts on iron absorption, it protects the body from oxidative damages, reduces stiffness of arteries, reduces tendency of platelets to clump each other, improves nitric oxide activity (dilatation of blood vessels) thus prevents high blood pressure & heart disease, also prevent eye disease, reduces risk of cataract, prevents the lining of lungs & prevents lung disease, it is a natural antihistamine (anti-allergy), eliminates toxins from the body. Deficiency of it causes Scurvy disease (brown spots on skin occurs, swelling of gums, bleeding from all mucous membrane, spots are more on thighs & legs, the person looks pale, feel depressed, cannot move, loss of teeth, suppurative wounds occur.

- ***Dietary fiber: -***

It is an eatable part of vegetables & fruit; our body cannot digest it just passes the small intestines & colon & excrete in stools; it is of two types 1) soluble fiber 2) insoluble fiber.

Soluble fiber dissolve in water & form a gel like material & helps in controlling blood cholesterol & blood glucose; it is found in apple, carrot, barley, oats, peas, beans watermelon etc.

Insoluble fiber do not dissolve & promotes excretion & increase bulk of the stool thus relief constipation & helps in elimination of toxins also. It is found in wheat flour, beans, cauliflower, potato, green beans, watermelon, beetroot, beet leaves etc.

This is the reason it is helpful in constipation conditions, it can eaten in pregnancy to relief constipation and get other benefits of it also.

Basic pharmacokinetics of dietary fiber (based on human intake in natural food products): -

Soluble fibers get dissolve in water & become a gelatinous substance; do not get digested; it helps to slow the digestion & help the body to absorb vital nutrient from eaten food.

Insoluble fibers do not dissolve in water but remain in fibrous form, and do not get digested; it helps the food pass through the digestive system and increase the bulk of stool & eliminate toxins also.

Basic clinical pharmacology of dietary fiber: -

It helps in slow down the digestive process thus gives a good control in blood glucose, improves insulin sensitivity, reduces risk of diabetes, maintains weight, helpful in obesity, reduces blood pressure, reduces cholesterol, reduces inflammation, reduces risk of heart disease, relieves constipation thus helpful in piles, fistula & other rectal disorders & disease, improves bowel movement thus improves bowel health, slowdowns the digestion thus improves quality of digestion, reduces risk of many types of cancer.

- ***Vitamin B1 (Thiamin): -***

It is called as Thiamin also; it is a water soluble vitamin, it belongs to B-complex family, it is an essential micro nutrient which cannot be made by our body.

Main sources of vitamin B1: -

It is present in watermelon, spinach, legumes, banana, wheat germ, liver, egg, meat, dairy products, nuts, peas, fruits, vegetables, cereals, rice, breads, oats etc.

Basic pharmacokinetic of vitamin B1 (based on human intake in natural food products): -

Intestinal phosphatases hydrolyze thiamin to make it free & absorbed in duodenum, jejunum mainly through active transport in nutritional doses & passive diffusion in pharmacological doses, very little is known about its absorption; it is metabolized in liver; it is excreted in urine & stored little in liver, heart, kidney, brain, muscles.

Clinical pharmacology of vitamin B1: -

It is needed for metabolism of glucose, amino acids (proteins), lipids (fats) etc; every cell of the body require it to form ATP (adenosine triphosphate) as a fuel for energy, also it enables the body to use carbohydrates as sources of energy; also nerve cells, heart cells, muscles cell require it to function normally; its deficiency causes beri-beri heart disease, weight loss, confusion, malaise, optic neuropathy, irritability, memory loss, delirium, muscles weakness, loss of appetite, tingling sensation in arms & legs, blurry vision, nausea, vomiting, reduce refluxes, shortness of breath

etc; it is helpful to immune system; excessive intake of carbohydrates, protein, glucose (speacially in body builders, athletes etc) increases the need of vitamin B1.

- ***Vitamin B2: -***

It is also called as Riboflavin, it is a water soluble vitamin, it is an essential micro nutrient, it helps many systems of the body; it is not synthesized in human body.

Main sources of vitamin B2: -

It is present in watermelon, liver, milk, dairy products, nuts, egg, fish, leafy vegetables, almonds, mushroom, lean meat,

Basic pharmacokinetic of vitamin B2 (based on human intake in natural food products): -

It is phosphorylated in the intestinal mucosa during absorption; mainly absorbed in upper gastrointestinal tract; the body absorbs little from a single dose beyond of 27mg; when excessive amount is eaten it is not absorbed; very little is known about its absorption. The conversion of it into its coenzymes takes place mainly in cells of small intestines, heart, liver, kidneys & throughout the body in many cells; it is excreted in urine & stored little in liver, heart, kidneys & in tissues of the body.

Basic clinical pharmacology of vitamin B2: -

It is needed by the body to keep skin, eyes, nerves, red blood cells healthy, it also helps adrenal gland, nerve cells, heart, brain to function; it also act in metabolism of food, amino acids (protein), fats, helps to convert carbohydrate into energy (Adenosine triphosphate formation- the energy body runs on). It plays an important role in functioning of mitochondria.

Its deficiency is called as Ariboflavinosis & causes weakness, throat swelling, soreness of mouth & tongue, cracks on skin, dermatitis, anemia, weak vision, itching & irritation in eyes, migraine.

- ***Vitamin B3: -***

It is called as Niacin or Nicotinic acid; it is in 2 forms niacin & nicotinamide acid; it is water soluble vitamin; it is an essential micro nutrient; it plays a role in over 200 enzymatic reactions in the body; It is produced in the body in small amount from tryptophan which is found in protein containing food & sufficient amount of magnesium, vitamin B6 & B2 (are needed to produce it).

Main sources of vitamin B3: -

It is present in watermelon, green peas, peanuts, mushroom, avocados, meat, egg, fish, milk, cereal, green vegetables, liver, chicken, coffee, potato, corn, pumpkin, tomato, almonds, spinach, enriched bread, carrots etc.

Basic pharmacokinetic of vitamin B3 (based on human intake in natural food products): -

If eaten in natural form it is absorbed in stomach & small intestines by the process of sodium-dependent carrier-mediated diffusion in 5 to 20 minutes; if taken in therapeutic doses get absorbed by passive diffusion in small intestines. Its uptake in brain requires energy, in kidneys & red blood cells requires a carrier. It is metabolized in liver in 2 ways either is conjugated with glycine or niacin is form into nicotinamide; it is stored little in liver unbounded to enzymes. It is excreted in urine.

Basic clinical pharmacology of vitamin B3: -

It regulates lipid level in the body; it acts on carbohydrate to form energy sources for the body, it ease arthritis, boost brain function, every part of body needs it to function properly, it helps convert food into energy by aiding enzymes & cellular metabolism, it acts as an antioxidant. It prevents heart disease. Deficiency of it causes pellagra, high blood cholesterol, memory loss, fatigue, depression, diarrhea, headache, skin problems, lesion in mouth, tiredness etc.

- ***Vitamin B5 (pantothenic acid): -***

It is also called as pantothenic acid, it is water soluble vitamin, it is a micro nutrient, it is necessary for making blood cells; acts to convert eaten proteins, carbohydrate, fats into energy; it is a component of coenzyme A; it is used in synthesis of coenzyme A. (coenzyme A acts on transport of carbon atoms within the cell).

Main sources of vitamin B5: -

It is present in watermelon, meat, chicken, liver, kidney, fish, grains, milk, dairy products, legumes etc.

Basic pharmacokinetic of vitamin B5 (based on human intake in natural food products): -

It is converted into free form by intestinal enzymes & in nutritional doses it is absorbed in intestinal cells via sodium dependent active transport system in jejunum & pharmacological doses are absorbed by passive diffusion; after absorption the free form of it is now transported to erythrocytes via plasma, in cells pantothenic acid is converted into CoA, all the body tissues can convert it into CoA & ACP (acyl carrier protein), after these two complete their jobs they are degraded to form free pantothenic acid & other metabolites. It is excreted in urine & stools & little in exhaled in carbon dioxide.

Basic clinical pharmacology of vitamin B5: -

It promotes skin, hair & eyes health, proper functioning of nervous system & liver, formation of red blood cells, making of adrenal hormones, sex hormones; it is very helpful in constipation, rheumatoid arthritis, acne, allergies, asthma, baldness, colitis etc.

Its deficiency causes fatigue, nausea, vomiting, irritability, neurological weakness, numbness, abdominal cramps, sleep disturbances, hypoglycemia etc.

- ***Vitamin B6: -***

It is also called as pyridoxine; it is involved in many aspects of macronutrients metabolism; it is present in many food products naturally.

Main sources of vitamin B6: -

It is present in watermelon, chicken, bread, egg, vegetable, soyabean, whole grain cereals, brown rice, fish, legumes, beef, nuts, beans, liver, citrus fruits, starchy vegetables, potato etc.

Basic pharmacokinetic of vitamin B6 (based on human intake in natural food products): -

It is absorbed in small intestines, but before absorption a phosphate group has to be removed making vitamin B 6 in free form & absorbed by passive transport, now reaches liver via portal vein, in liver to get metabolized & flown into the blood stream it is bound with albumin & some are taken up by red blood cells, once getting in blood it can function & promote health & it is excreted mainly in urine & little is excreted in stools, it is very little stored in tissues, muscle tissues, liver, brain, kidneys, spleen.

Basic clinical pharmacology of vitamin B6: -

It is needed for proper development & function of brain in children; it is needed for neurotransmitter, histamine, haemoglobin synthesis & function. It serves as coenzyme (cofactor) for many reactions in the body, it is the master vitamin for processing amino acids & some hormones, it is needed by the body to prepare serotonin, melatonin & dopamine, it is better to intake it during treatment of tuberculosis. It supports adrenal glands to function; it acts as a coenzyme in the breakdown & utilization of fats, carbohydrates, protein, it is important for immune system, it helps in treatment of nerve compression like carpal tunnel syndrome, premenstrual syndrome, depression, arthritis, high homocysteine level, diabetes, asthma, kidney stones etc.

Its deficiency causes seborrheic dermatitis (eruption on skin), atrophic glossitis with ulceration, conjunctivitis, neuropathy, anaemia etc.

- ***Folate (vitamin B9): -***

Folate is an essential micro nutrient, it is a natural form of vitamin B9, it serves many important functions of the body, it plays an important role in cell growth & formation of DNA, RNA & other genetic material & helps in treating many diseases; it name is derived from Latin word Folium, which means leaf, leafy vegetables have it in good amount; Folic acid is a synthetic form of vitamin B9.

Main sources of folate: -

It is present in watermelon, dark green leafy vegetables, fruits, nuts, beans, dates, seafood, egg, dairy products, meat, chicken, legumes, beetroot, citrus fruits, broccoli, spinach, cereals etc.

Basic pharmacokinetic of folate (based on human intake in natural food products): -

Its absorption is complicated because folate present in food are of many different forms, some of which cannot be absorbed until broken down by intestinal enzymes; it is not absorbed more than 50%; dietary folate contains glutamate that need to separate it from glutamate before absorption starts; It is absorbed in duodenum & jejunum, after absorption it is converted into tetrahydrofolate (the active form of folate), than a methyl group is added to it to form methyltetrahydrofolate; now the body uses it for various functions & metabolism; the body can store folate 20-70mg in liver which is enough for 3 -6 months for the body; it gets excreted in urine & little in stools & bile.

Basic clinical pharmacology of folate: -

It is needed by the body to make DNA, RNA & other genetic material; it prevents many disease & conditions like anaemia, stroke, cardiac diseases, cancers, neurological diseases, macular degeneration (eye disease), palpitation, sores in mouth & tongue, hair fall, graying of hair. It is important in fertilization in male & female, essential during pregnancy to prevent neural tube defect in embryo (it is needed more), it protect us from free radicals & oxidation thus prevent cancers, it is essential in red blood cells formation, reduces high levels of homocysteine.

Its deficiency may cause anaemia, tiredness, palpitation, breathlessness, hairfall, neural tube defect in baby during pregnancy etc.

- ***Choline: -***

It is water soluble vitamin & essential nutrient, it is a constituent of lecithin; it helps in many functions of the body.

Main sources of choline: -

It is present in watermelon, egg, peanut, fish, dairy products, wheat, beetroot, spinach, beans, whole grains etc.

Basic pharmacokinetics of choline (based on human intake in natural food products): -

Choline is mostly present in food in free form; it is absorbed in small intestine via transporter proteins & metabolized in liver; excessive choline is not stored but converted into phospholipids; it is changed into Trimethylamine in liver & is excreted in urine.

Basic clinical pharmacology of choline: -

It helps the nerves to develop signals. Our body makes some amount of choline, but should be consumed to avoid deficiency; it helps liver function, brain development, muscles movement, cell messenger system, DNA synthesis, nervous system, gall bladder function; it can be taken in pregnancy because it prevents neural tube defect. It aids in fats & cholesterol metabolism & prevent excessive fat building in liver.

- ***Calcium: -***

It is natural essential mineral for the body, it is among the electrolytes of the body; its symbol is Ca & atomic no. 20.

Main sources of calcium: -

It is present in watermelon, milk, banana, cheese, green leafy vegetables, soya beans, nuts, fish, meat, egg, bread, flour, yogurt, almonds, kale, soybean, spinach, beetroot etc.

Basic pharmacokinetics of calcium (based on human intake in natural food products): -

Calcium is absorbed in duodenum & upper jejunum (when calcium intake is low) by transcellular active transport process, this depends on action of calcitriol & intestinal vitamin D receptors & when calcium intake is high, absorbed by paracellular passive process throughout the length of small intestine by 3 major steps, entry across the brush border, intracellular diffusion via calcium-binding protein & extrusion; Vitamin D is necessary for absorption of calcium, also vitamin C, E, k, magnesium & exercise increases the absorption of calcium. Also the level of calcium is regulated by calcitonin released by thyroid gland it reduces calcium level in blood when it is excessive & increases the excretion of calcium via kidneys; Parathyroid hormones (PTH) released by parathyroid gland increases the blood level of calcium when body need it or calcium is less in blood & promotes reabsorption of it in kidneys (calcitonin & PTH both have opposite function). Intestines can absorb 500 to 600 mg of calcium at a time; it is mostly stored in bone tissues & teeth & excreted in stool & sweat & little in urine depended upon the level of it in blood. Also estrogen act on transport of blood calcium in bones thus women mostly suffer from osteoporosis after menopause.

Basic clinical pharmacology of calcium: -

Calcium acts on bone health, communication between brain & other parts of the body, muscles contraction, blood clotting; it is a co-factor for many enzymes, it relaxes the smooth muscles & blood vessels; it maintains heart rhythm, muscles function; it is more needed in childhood & deficiency of it in childhood may cause convulsions (seizure); Excessive level of it in blood is called as hypercalcemia & may lead to kidney stone formation, heart attack, stroke, loss of appetite, excessive urination, memory loss etc; its low level in blood is called as hypocalcemia & may lead to cramps in the body, weak bones, weak teeth, numbness, tingling etc.

Contraindication: -

Sarcoidosis, excessive level of calcium in blood, very severe constipation, kidney stones, increased activity of parathyroid gland etc. Hypersensitivity of calcium, severe cardiac diseases, hypercalcemia, hypercalciuria, severe kidney stones etc.

- ***Iron: -***

It is an essential mineral for our body; its symbol is Fe & atomic no. 26; it is an important component of heamoglobin (heamoglobin binds oxygen in lungs & supply it to whole body, it is oxygen carrier).

Main sources of iron: -

It is present in watermelon, meat, dates, spinach, egg, nuts, dark leafy green vegetables, broccoli, pumpkin seeds, chicken, legumes, fish, banana, cabbage, kidney, almonds, beetroot etc.

Meat is the best source of iron, it provides Fe^{+2} directly which can be transported from intestine to blood steam through Fe^{+2} transporter ferroportin (this binds with transferring & delivered into tissues).

Basic pharmacokinetics of iron (based on human intake in natural food products): -

The absorption of iron is not known fully; about only 10% of iron taken in food is absorbed; it is absorbed in duodenum & upper jejunum mainly & at the end part of ileum; low pH is needed for its absorption, after absorption it get bind to transferring (each transferring can carry 2 atoms of iron); ceruloplasmin (protein) also helps in binding of iron; Hepcidin a hormone produced by liver is released when iron stores are full & inhibits iron transport & binding, thus reduces the absorption of iron; vitamin C & copper enhances iron absorption.

Storage of iron: -

Iron is stored in liver (in hepatocytes & kupffer's cells) kupffer's cells play an important role in recycling body iron, they ingest aged RBC liberate iron for it & reuse by breaking down heamoglobin. Little iron is stored in liver, heart, & kidneys in form of ferritin also little in bone marrow, spleen.

Excretion of iron: -

The body does not possess a physiological mechanism for regularly eliminating iron from the body because most of it is recycled by liver cells; iron is lost within cells, from skin & interior surface of the body (intestines, urine, breathe).

Basic clinical pharmacology of iron: -

It is an important component of Haemoglobin (heamoglobin bind oxygen in lungs & supply it to whole body); iron is beneficial for nails, hair, skin etc; it acts on blood production, its deficiency causes Anaemia (low haemoglobin level in blood) (this causes reduced in oxygen carrying capacity & supply of it); most of the iron is present in haemoglobin, it consist of one heme (iron), one protein chain (globin) this allows it to bind & load oxygen from the lungs & supply it to whole body.

Unbounded or free iron is highly destructive & dangerous it can trigger free radical activity which can cause cell death & destroy DNA.

- ***Magnesium: -***

It is an important essential mineral; its symbol is Mg & atomic no. 12; it is a co-factor for more than 300 enzymes that regulates functions in the body. Its normal range in blood is 0.75 to 0.95 millimoles (mmol)/L.

Main sources of magnesium: -

It is present in watermelon, spinach, beetroot, meat, egg, nuts, dark leafy green vegetables, broccoli, pumpkin seeds, dates, chicken, fish, legumes etc.

Basic pharmacokinetics of magnesium (based on human intake in natural food products): -

It is absorbed about 20 to 50% only; it is absorbed about 40% in distal intestine when the level of it is low via passive paracellular transport & about 5% in descending colon when the level of it is high via active transcellular transport. Vitamin D increases its absorption & also acts on its excretion in urine. It is excreted in urine & stool; it is stored in bones.

Basic clinical pharmacology of magnesium: -

It is a co-factor for more than 300 enzymes that regulates functions in the body. It act on protein synthesis, muscles & nerve function, blood glucose, control blood pressure, it is required for energy production, bone development, synthesis of DNA & RNA. It also plays a role in active transport of calcium & potassium ions, muscles contraction, normal heart rhythm etc.

- ***Phosphorus: -***

It is an essential mineral; its symbol is P & atomic no. 15, it is needed for many parts & functions of the body.

Main sources of phosphorus: -

It is present in watermelon, beetroot, meat, nuts, beans, fish, chicken, dairy products, soy, grains, lentils etc.

Basic pharmacokinetics of phosphorus (based on human intake in natural food products): -

It is absorbed 70-85%, it is absorbed 30% in duodenum, 20% in jejunum, 35% in ileum; it is absorbed in inorganic phosphate form by 2 separate process first when the phosphorus intake is high mainly after meals by paracellular sodium independent passive diffusion pathway & second is transcellular sodium dependant carrier-mediated pathway this falls under the control of vitamin D & etc. When calcium level is too high in the body phosphorus is less absorbed, optimum calcium : phosphorus ratio is helpful in its absorption (excess of anyone decreases the absorption of both). It is stored in bones 85% & rest in tissues; it is excreted 80% in urine & rest in stools (excretion of it is a regulatory action of parathyroid hormone (PTH), vitamin D, and fibroblast).

Basic clinical pharmacology of phosphorus: -

It is present in nature combined with oxygen as phosphate. It acts on growth of teeth, bones, repairs of cells & tissues. It plays an important role in metabolism of carbohydrate, fats, protein & ATP. It works with B-complex vitamins & helps kidney function, muscles contraction, normal heart beats, nerve impulse etc.

- ***Zinc: -***

It is a trace mineral; symbol is Zn & atomic no. 30; it is necessary for human body as it plays vital role in health.

Main sources of zinc: -

It is present in watermelon, meat, fish, legumes, beans, egg, dairy products, seeds, nuts, whole grains, beetroot etc.

Basic pharmacokinetics of zinc (based on human intake in natural food products): -

It is absorbed 20 to 40%, its absorption depends on its concentration & is absorbed in whole intestines (jejunum has high rate of its absorption) via carrier-mediated mechanism, it is released from food as free ions during digestion.

Zinc from animal sources is easily absorbed comparing to plants sources. It is present in bile & pancreatic juices which is released in duodenum & is reused by the body this is called as endogenous zinc & zinc present is food sources is called as exogenous zinc. Its absorption depends on 2 proteins- Albumin & metallophinonein. Albumin enables zinc to be transported from plasma into enterocytes. It is stored in muscles, bones mainly & little in prostate, liver, kidneys, skin, brain, lungs, heart & pancreas. It is excreted in stools 80% & rest in urine & sweat. Metallophinonein binds to zinc to make it unavailable & excrete it in stools when zinc is excess in the body, & production of metallophinonein is reduced when zinc is less in the body to make zinc available for the body.

Basic clinical pharmacology of zinc: -

It is necessary for immune system, prevents skin diseases, heal skin diseases, helps stimulate activity of at least 100 different enzymes in the body; it is required in little amount in the body, but children, pregnant & old aged need it more. It promotes growth in children, synthesize DNA & acts on wound healing, it is best in treating initial diarrhea & cold cough. This makes watermelon & beetroot ideal during motions. It improves learning, memory, fertility etc. It heals acne, attention deficit hyper activity disorder (ADHD), osteoporosis, pneumonia etc.

- ***Manganese: -***

It is an essential mineral & micro nutrient, needed by the body for proper health. Its symbol is Mn & atomic no. 25.

Main sources of manganese: -

It is present in watermelon, nuts, beans, legumes, brown rice, leafy green vegetables, pineapple, beetroot etc.

Basic pharmacokinetics of manganese (based on human intake in natural food products): -

It is absorbed 40%, it is absorbed more in women than men; if intake of it is more, than absorption is less & if intake is less, absorption is more; its absorption takes place in small intestines, after absorption it is bounded to blood protein transferring & transmanganin & transport via blood stream to tissues; it is absorbed by inhalation & dermal (skin) also; it crosses brain blood barrier. It is stored in bones, liver, kidney, pancreas; it is excreted mainly in bile & stools, little in urine & sweating; unused manganese is transported to liver for excretion & excreted via bile mainly.

Basic clinical pharmacology of manganese: -

It is needed for proper health of skin, bones, cartilage etc; it helps in glucose tolerance, regulates blood sugar, reduces inflammation, reduces premenstrual cramps, it also aids in formation of connective tissues, bones, sex hormones, blood clotting, metabolism of carbohydrates & fats; it facilitates calcium absorption

- ***Copper: -***

It is an essential micronutrient mineral; its symbol is Cu & atomic no. 29; there are lot of health benefits of it; it is needed in little amount in the body. It is present in beetroot leaves & sugarbeet.

Main sources of copper: -

It is present in beetroot leaves, watermelon, spirulina (water-plant), nuts, seeds, lobster, leafy green vegetables, guava, grapes, green olive, kiwi, mango, pineapple, pomegranate, egg etc.

Basic pharmacokinetics of copper (based on human intake in natural food products): -

It is absorbed 30 to 50%; it is absorbed easily than other minerals, its absorption depends on the copper present in the body, when the intake of it is less, absorption is increased & when intake is more absorption is less, it is mainly absorbed in small intestines & little in stomach via carrier-mediated process; its absorption is influenced by amino acids, vitamin C & other dietary factors. After absorption it is bound primarily to albumin, peptide & amino acids & transported to liver. Copper is secreted into plasma as a complex with ceruloplasmin. It is mainly stored in liver little in brain, heart & kidneys; it is excreted mainly in bile & little in urine.

Basic clinical pharmacology of copper: -

Together with iron it enables the body to form RBC; it helps to maintain health of bones, blood vessels, nerves & immune system; it also acts on iron absorption, protein metabolism, growth of body, it acts also on development of brain, heart & other organ; it is needed by the body for making ATP, collagen. Excessive of it may cause Wilson's disease.

Deficiency of copper: -

It is very rare; but may cause cardiovascular disease, genetic defects, inflammation of optic nerve etc.

Total amino acids present in beetroot: -

Absorption & digestion of amino acid.

When we eat high-protein foods, body breaks down protein into amino acids and peptides through digestive enzymes, such as pepsin & pancreas produces trypsin, chymotrypsin and other that aid in protein digestion.

Pepsin is the primary enzyme responsible for digesting protein; it acts on the protein molecules & breaks the bonds – called peptide bonds – that hold the protein molecules together. Next, these smaller chains of amino acids move in the stomach & then in small intestine where they're further broken down by enzymes released by the pancreas.

Small intestine contains finger-like extensions called micro-villi. These structures enhance its ability to absorb dietary nutrients. Now the semi digested material pass through brush border and baso-lateral membranes of small intestine & di-tripeptides are absorbed by passive transport (facilitated or simple diffusion) or active transport (Na+ or H+ co-transporters) pathways. Di and tripeptides are more efficiently absorbed than free amino acids which in turns are better absorbed than oligopeptides. They're released into the bloodstream and used for various biochemical reactions.
Each amino acid has a different role in the human body. Upon absorption, some amino acids are incorporated into a new protein. Some fuel your muscles and support tissue repair. Others are used as a source of energy.
Tryptophan and tyrosine, for example, promote brain health. These amino acids support the production of neurotransmitters, leading to increased alertness and optimum nerve responses. Tryptophan also assists with serotonin production, lifting your mood and keeping depression at bay.
Phenylalanine serves as a precursor to melatonin, epinephrine, dopamine and other chemicals that regulate your mood and bodily functions. Methionine helps your body absorb selenium and zinc, two minerals that promote overall health. Some amino acids, such as isoleucine, play a vital role in hemoglobin production and glucose metabolism.

- ***Tryptophan: -***

It is an amino acids (protein) that is useful in bio-synthesis of protein; it is essential in human because body cannot make it); it is a precursor of neuro-transmitter serotonin, melatonin, vitamin B3; it is a sedative also.

Main sources of tryptophan: -

Salmon oil, egg, spinach, milk, seeds, fenugreek seed, soy products, nuts, fish, meat, wheat, banana etc.

Basic pharmacokinetics of tryptophan (based on human intake in natural food products): -

It is absorbed in small intestine & reached the blood circulation, it passes the blood brain barrier & in brain cells it is metabolized into indolamine neuro-transmitter, niacin, a common example of indolamine is serotonin derivative from tryptophan. Tryptophan is converted into serotonin in the brain & body; it is believed that tryptophan supplements should be taken with carbidopa, which blocks the blood brain barrier. (Serotonin (5HTP) 5 hydroxytryptamine, is a monoamine neuro-transmitter. It contributes in feelings of well-being, happiness, reward, learning, memory, many physiological functions).
In the pathway of tryptophan/serotonin, melatonin hormone is produced. Melatonin regulates sleep-wake cycle. It is primarily released by pineal gland in brain. It controls circadian (daily clock) rhythms.
Pineal gland releases it at night more & very little in day light. It improves immune system function.
Natural sources of melatonin are tomato, pomegranate, olive, grapes, broccoli, cucumber, barley, seeds, nuts etc.
Fructose malabsorption causes improper absorption of tryptophan in intestine thus leading to low level of it & may cause depression.

Basic clinical pharmacology of tryptophan: -

It is necessary for normal growth of infants; nitrogen balance in adults, it aids in sleep pattern, mood. It is necessary for melatonin & serotonin formation in body, it enhances mental & emotional wellbeing, manages pain tolerance, weight etc. it also helps in build muscle tissue, essential for vitamin B3 production, relives insomnia, reduces anxiety, depression, migraine, OCD, helps immune system, reduces cardiac spasms, improves sleep patter etc.

- ***Threonine: -***

It is an amino acid used in biosynthesis of proteins; it is an essential amino acid important for tooth enamel, collagen, elastin, nervous system, fats metabolism, it prevents fats buildup in liver, useful in intestinal disorders, anxiety, and depression.

Main sources of threonine: -

Cheese, chicken, fish, meat, lentil, black seed, nuts, soy etc.

Basic clinical pharmacology of threonine: -

It is useful in nervous system disorders, multiple sclerosis, spinal spasticity, makes bones, joints, tendons, ligament stronger, it helps the immune system, promotes heart health.

- ***Isoleucine: -***

It is an amino acid that is used in the biosynthesis of proteins, it is an essential amino acid means the body cannot make it & we depend on food sources, it plays & helps many functions of the body.

Main sources of isoleucine: -

Meat, mutton, fish, cheese, egg, seeds, nuts, soybeans, milk, legumes, fenugreek seed etc.

Basic pharmacokinetics of isoleucine (based on human intake in natural food products): -

It is absorbed in small intestine by sodium-dependant active transport. It is metabolized in liver.

Basic clinical pharmacology of isoleucine: -

It promotes glucose consumption 7 uptake, it is anti-catabolic, enhances athletic performance & best for pre-workout, it acts on wound healing, detox of nitrogenous waste in the body, stimulates immune system, promotes secretion of many hormones, helps in heamoglobin formation, regulating blood glucose, energy in the body, built muscles, helpful to brain for its function.

- ***Leucine: -***

It is branched chain amino acid (BCAA) it is ketogenic amino acid; it is necessary when we do exercise, it stimulates protein synthesis & assists in muscle building.

Main sources of leucine: -

Cheese, soyabean, meat, nuts, chicken, seeds, fish, seafood, beans.

Basic clinical pharmacology of leucine: -

It helps regulate blood glucose, promotes growth, recovers the muscles & bone tissues, acts on production of growth hormones, repairs the tissues, essential for muscle building, it burns fats, controls obesity, promotes lean muscles growth.

- ***Lysine: -***

It is an essential amino acid, which our body cannot prepare and we need to eat it from food sources. It necessary for many body functions, acts in building blocks of protein (muscles).

Main sources of lysine: -

Red meat, chicken, egg, fish, beans, lentils, wheat germ, nuts, soybeans, spirulina, fenugreek seed, shrimp, pumpkin seed, tuna, cheese, milk etc.

Basic pharmacokinetics of lysine (based on human intake in natural food products): -

It is absorbed from the lumen of the small intestine into the enterocytes by active transport, it undergo first pass metabolism in liver & is metabolized in liver.

Basic clinical pharmacology of lysine: -

It helps the body in tissue growth, repair muscles injury, promote collagen formation, help the body to produce enzymes, antibodies, hormones, supports immune system, its deficiency causes fatigue, irritability, nausea, hair loss, anorexia, inhibited growth, anemia, problems with reproductive system, it is very helpful in treating cold sores (herpes), control blood pressure, diabetes, osteoporosis, helps athletes performance, helpful in treating cancers, reduces anxiety, increase absorption of calcium, improves digestion & prevent leaky gut, helpful in pancreatitis.

- ***Methionine: -***

It is a sulfur containing amino acid; it is essential; it plays a critical role in the metabolism & health; it act on normal cell functioning, growth & repair. It is also a chelating agent for heavy metals; due to its sulfur contain it is helpful in hair, nail health & growth & good for skin health; it reduces cholesterol by increase the production of lecithin in liver & reduces fats formation in liver, also protects kidneys, liver from hepatotoxins, it is an antioxidant. It is absorbed in lumen of small intestines into enterocytes by active transport & metabolized in liver.

Main sources of methionine: -

Meat, mutton, fish, chicken, cheese, egg, beans, milk, nuts, shellfish etc.

- ***Cystine: -***

It is the oxidized dimer form of amino acid, it is nonessential; the body uses it to produce taurine & other amino acids; it is a sulfur containing amino acid; our body uses vitamin B6 with the help of cystine; it heals burns, wounds, bronchitis, assist in supply of insulin, it increase level of glutathione in liver, lungs, kidneys & bone marrow. It is anti-aging, anti-inflammatory, anti-arthritis, anti-rheumatoid arthritis.

Main sources of cystine: -

Meat, egg, milk, garlic, onion, broccoli, oats, wheat germ, lentils etc.

- ***Phenylalanine: -***

It is an aromatic essential amino acid in human; it plays a key role in biosynthesis of other amino acids; it is important in the structure & function of many proteins & enzymes. It is precursor of melanin, dopamine, noradrenalin hormone, thyroxin hormone. It is converted in tyrosine & used in biosynthesis of dopamine & noradrenalin. It improves memory, reduces pain of hunger; it is anti-depressant; it is also a building block protein; it is useful in vitiligo, depression, ADHA, parkinson's, multiple sclerosis, pain, osteoarthritis, rheumatoid arthritis, fat burn & helpful in alcohol withdrawal symptoms.

Main sources of phenylalanine: -

Pumpkin seed, nuts, seeds, soy, meat, fish, chicken, egg, beans, milk etc.

- ***Tyrosine: -***

It is a nonessential amino acid; it is also called as 4-hydroxyphenylalanine; it is useful in cell synthesis of protein; it is a building block protein; body prepares it from phenylalanine. It is a precursor & used to produce noradrenalin, dopamine, & thyroxin & melanin hormones. It reduces stress, improves memory, it promotes growth, mental health, skin health, fat burn. It acts as a mood elevator, anti-depressant, improves memory, mental alertness, its deficiency can cause hypothyroidism leading to low blood pressure, low body temperature (hypothermia), stress, fatigue, narcolepsy; it helps thyroid gland, adrenal gland, pituitary gland to function properly. It is absorbed in small intestine by sodium-dependant active transport; after absorption it reaches the blood & crosses the blood brain barrier (BBB) & enters the brain cells & gets metabolized into catecholamine (noradrenalin). Human body regulates it amount by eating it by food sources & making inside the body (nonessential). The body does not store it much for later uses.

Main sources of tyrosine: -

Meat, fish, egg, milk, nuts, beans, oats, wheat, black seeds etc.

Dopamine: -

It regulates reward & pleasure centers in brain; it is a chemical important for memory, motor skills & etc.

Nor-adrenaline & adrenaline: -

These hormones are responsible for fight & flight response in stressful situation & also controls many functions of the body; it is secreted by adrenal glands.

Thyroxin: -

It is secreted by thyroid gland; it regulates metabolism, blood pressure, digestion, energy etc.

Melanin: -

It is pigmented hormone, gives our skin, hair, eye their colour; dark skinned people have more melanin in their skin than light skin people (depend on exposure to sunlight).

- ***Valine: -***

It is an essential nutrient for vertebrates, biosynthesis of protein; it is an aliphatic & extremely hydrophobic essential amino acid; it is branched chain of amino acid (BCAA); it is important for growth, repair, blood glucose regulation, for energy; it stimulates CNS, proper mental function.

Main sources of valine: -

Cheese, soy, beans, nuts, fish, meat, chicken, mushroom, seeds, nuts, whole grains etc.

- ***Histidine: -***

It is an amino acid used in biosynthesis of protein; it is semi essential amino acid, needed by human for production of histamine & also for growth & tissue repair, it is helpful in maintaining myelin sheaths that covers the nerves & protects the nerves.

Main sources of histidine: -

Meat, mutton, fish, milk, egg, seeds, nuts, chicken, cheese, soy, beans, whole grains, fenugreek seeds.

Basic pharmacokinetics of histidine (based on human intake in natural food products): -

It is absorbed in small intestine via active transport requiring the presence of sodium.

Basic clinical pharmacology of histidine: -

It plays many roles in immunity, gastric secretion & sexual functions. It is also required for blood cell formation & protects tissues against damage of radiation & heavy metals. It keeps normal pH of 7 in the body, useful in rheumatoid arthritis, allergy, ulcer & anemia caused by kidney failure or dialysis. It is an antioxidant, anti-inflammatory, reduces cholesterol.

- ***Arginine: -***

It is among conditional essential amino acid the body needs to function properly; it is made in liver; it plays an important role in building protein thus helpful in body building.

Main sources of arginine: -

Chicken, pumpkin seeds, spirulina, dairy products, red meat, fish, egg etc.

Basic pharmacokinetics of arginine (based on human intake in natural food products): -

It is absorbed in jejunum mainly from oral diet.

Basic clinical pharmacology of arginine: -

It releases nitric oxide in the blood & nitric oxide dilates the blood vessels thus increases the blood supply & controls high blood pressure, it improves erection, builds muscles etc. it also act on release of growth hormone, insulin & other substances in the body. It also improves heart health, athletes performance, stimulates immune system; citrulline present in watermelon is converted into arginine in kidneys, please refer lesson on watermelon.

- ***Alanine: -***

It is a non-essential amino acids that is present in blood plasma in its free state in high levels; it is involved in sugar & acid metabolism, protein synthesis, it increases immunity, provides energy for muscles tissues, brain & CNS, it act on tryptophan, vitamin B6 metabolism; it is an important sources of energy for muscles; it helps the body to convert simple sugar (glucose) into energy; it is produced in the body. It increases exercise capacity; reduces muscle fatigue, boost immunity, it is antioxidant; anti-aging; increases muscle growth; ideal pre & post workout, reduce blood sugar, prevent liver disease, helps the liver to eliminate toxins, improves CNS functioning, helpful in benign prostate hypertrophy. It is digested in small intestine; it is converted into pyruvic acid by alanine aminotransferase-1; during fasting condition alanine derived from protein breakdown is converted into pyruvate & used to synthesis glucose by gluconeogenesis in liver, it is excreted in urine via urea cycle. It is stored little in skeletal muscles.

Main sources of alanine: -

Meat, fish, egg, milk, aleovera, honey, black seeds, nuts etc.

- ***Aspartic acid: -***

It is a non-essential amino acid; it is over all negatively charged & plays an important role in synthesis of other amino acid, citric acid & urea cycles; it is found in animals, plants, sugarcane, sugarbeet. It may be a neurotransmitter; it strengthens the muscles, improves heart function, helps in maintaining mental health, reduces tiredness, improves athletic performance, increases muscle size, reduces depression & fatigue. It is absorbed in small intestine by active transport.

Main sources of aspartic acid: -

Meat, oysters, seeds, oats, avocado, sugar beet, milk, egg, nuts, cereals etc.

- ***Glutamic acid: -***

It is a nonessential amino acid. It is an excitatory neuro-transmitter; it is necessary for biosynthesis of proteins; body uses it for several key functions within the body like making other neuro-transmitters such as GABA; it promotes brain health, muscles health, intelligence, mood & mental alertness. It is called as chemical messenger. It plays an important role in body's disposal of excessive waste like nitrogen. It is absorbed in lumen of small intestine into enterocytes by active transport & excreted in urine mainly. It is almost about 2 kgs, storage in natural form in brain, kidneys, liver, muscles etc.

Main sources of glutamic acid: -

Meat, chicken, fish, egg, milk, wheat, mushroom, soy, broccoli, walnut, peas etc.

- ***Glycine: -***

It is a nonessential amino acid that body needs for growth & maintenance of tissue & need to prepare hormones & enzymes. It is inhibitory neurotransmitter. It helps in preparing glutathione (a powerful antioxidant & reduces free radicals, delay aging). It is helpful in preparing of creatine (provides energy to muscles to perform exercise etc & acts on muscle contraction), beneficial for brain health, bone health, alzheimer's, schizophrenia, sleep disorder, stroke, burns, protects kidney & liver from harmful side effects of drugs used after organ transplant, heals wound & ulcers, it is anti-inflammatory, improves skin health.

Main sources of glycine: -

Meat, fish, milk, legumes etc.

- ***Proline: -***

It is a protein-genic amino acid used in biosynthesis of proteins. It heals cartilages, cushion joints, tendons, ligament, heart muscles, connective tissues & helps in formation of collagen.

Main sources of proline: -

Soy, pumpkin seed, lentils, black beans, quinoa etc.

- ***Serine:-***

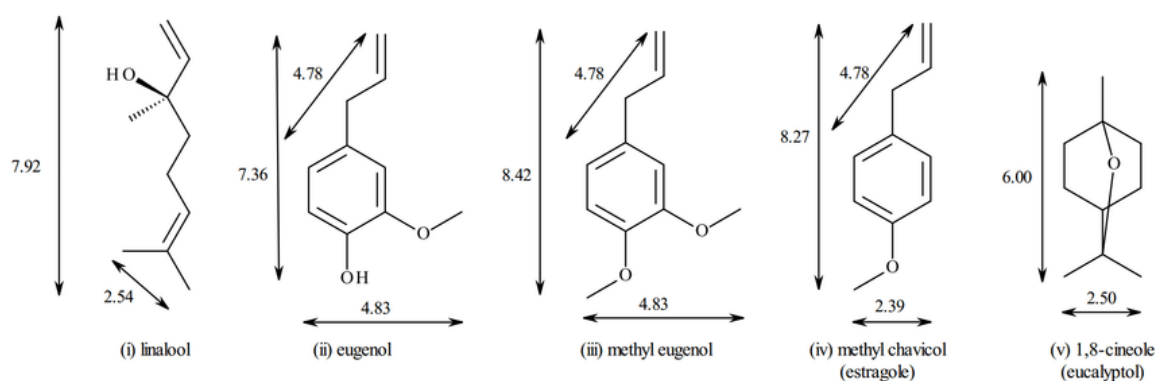
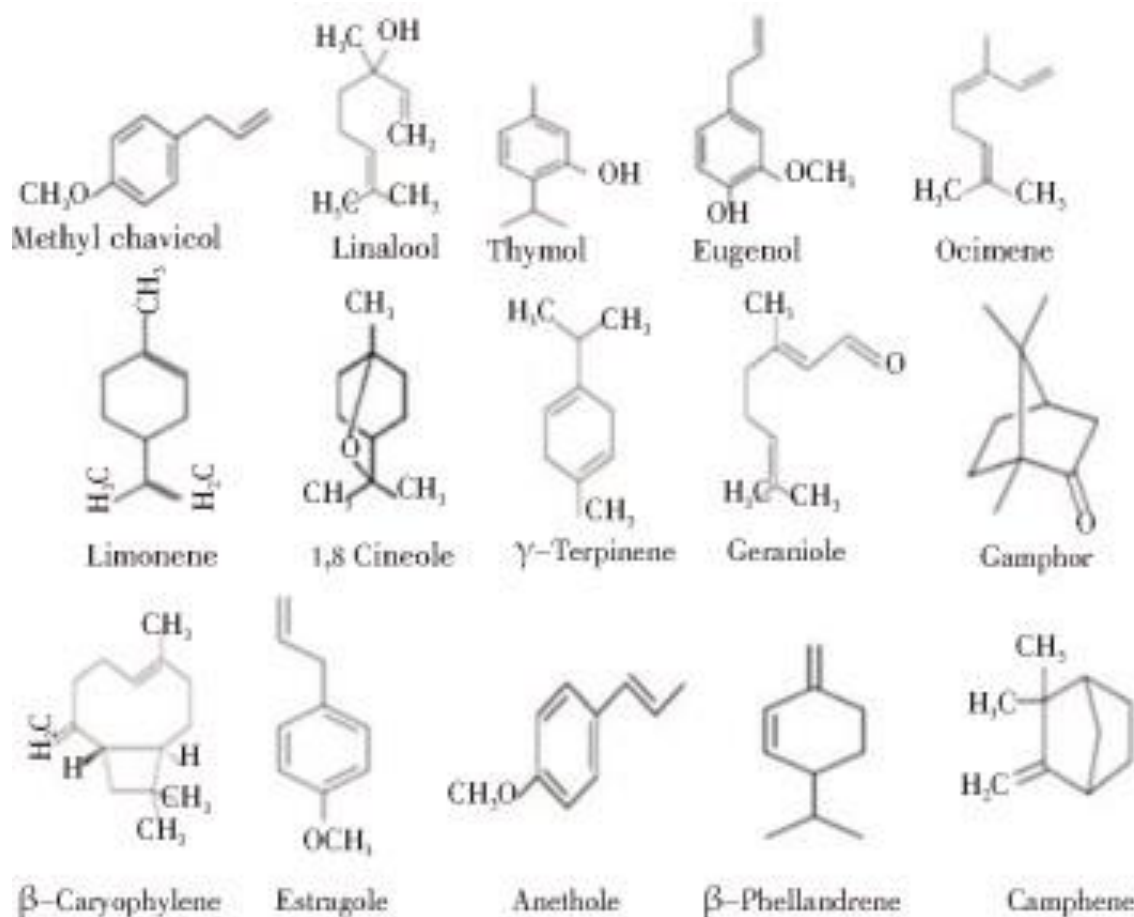
It is a nonessential amino acid, important for synthesis of protein, fats metabolism, muscle growth, immune system; it is a precursor of many amino acids, helpful in enzyme catalyze its reaction, overall health, physical & mental health.

Main sources of serine: -

Soybean, egg, lentils, meat, fish, nuts, almonds, walnut etc.

Basil leave	Amino acid contain in basil leaves
Weight (g)	3 grams (5 leaves)
Tryptophan(mg) (% RDI)	1 (0%)
Threonine(mg) (% RDI)	3 (0%)
Isoleucine(mg) (% RDI)	3 (0%)
Leucine(mg) (% RDI)	5 (0%)
Lysine(mg) (% RDI)	3 (0%)
Methionine(mg) (% RDI)	1 (0%)
Cystine(mg) (% RDI)	1 (0%)
Phenylalanine(mg) (% RDI)	3 (0%)
Tyrosine(mg) (% RDI)	2 (0%)
Valine(mg) (% RDI)	3 (0%)
Histidine(mg) (% RDI)	1 (0%)
Arginine(mg)	3
Alanine(mg)	3
Aspartic acid(mg)	8
Betaine(mg)	0
Glutamic acid(mg)	7
Glycine(mg)	3
Proline(mg)	3
Serine(mg)	2

Basil, fresh	
Nutritional value per 100 g (3.5 oz)	
Energy	94 kJ (22 kcal)
Carbohydrates	2.65 g
Dietary fiber	1.6 g
Fat	0.64 g
Protein	3.15 g
Vitamins	Quantity%DV†
Vitamin A equiv. beta-Carotene	33% 264 μg 29% 3142 μg
Thiamine (B1)	3% 0.034 mg
Riboflavin (B2)	6% 0.076 mg
Niacin (B3)	6% 0.902 mg

Pantothenic acid (B5)	4% 0.209 mg
Vitamin B6	12% 0.155 mg
Folate (B9)	17% 68 μg
Choline	2% 11.4 mg
Vitamin C	22% 18.0 mg
Vitamin E	5% 0.80 mg
Vitamin K	395% 414.8 μg
Minerals	Quantity%DV[†]
Calcium	18% 177 mg
Copper	19% 0.385 mg
Iron	24% 3.17 mg
Magnesium	18% 64 mg
Manganese	55% 1.148 mg
Phosphorus	8% 56 mg
Potassium	6% 295 mg
Selenium	0% 0.3 μg
Sodium	0% 4 mg
Zinc	9% 0.81 mg
Other constituents	Quantity
Water	92.06 g

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- ***Research: -***

Supporting liver health: -

A 2015 study in rats concluded that antioxidants in a powdered preparation that included tulsi, or holy basil, had a positive impact on liver health. The scientists applied the powder after using a toxin to induce liver injury. Tulsi — a plant that is very different from the basil in the average Western supermarket — plays a role in Indian traditional medicine.

Fighting cancer: -

A review published in 2013 looked at whether tulsi, or holy basil, could prevent cancer. The authors concluded that the phytochemicals in holy basil may help prevent certain types of skin, liver, oral, and lung cancers. They appeared to do this by increasing antioxidant activity, changing gene expression, triggering cell death, and slowing cell division.

However, the studies in this review were preclinical or performed in animals. Confirming the effects will require further research.

Protecting against skin aging: -

According to research published in 2011, sweet basil has properties that might help protect the skin from some effects of aging.

In the study, the scientists applied a basil extract to laboratory models of skin. The results suggested that including basil extracts in topical skin creams might improve skin hydration and reduce roughness and wrinkling. Extracts of basil at certain doses may have this effect; consuming basil will not necessarily benefit the skin. However, the antioxidants in basil and other plant-based foods may have a protective effect if a person consumes them as part of a varied diet.

Reducing high blood sugar: -

Some practitioners of traditional medicine commonly recommend basil to help manage blood sugar levels. A 2019 study in rats found that an extract of sweet basil leaves helped reduce high blood sugar levels. The results also suggested that basil leaves may help treat long-term effects of high blood sugar. If further investigations confirm these findings, basil extracts could prove useful for people with diabetes.

Supporting cardiovascular health: -

A 2011 review reported on findings that a sweet basil extract briefly reduced high blood pressure, possibly due to the extract's eugenol content. Eugenol can block calcium channels in the body, lowering high blood pressure. However, 2 minutes after the

researchers used the extract, the blood pressure returned to its high levels. In another study, 24 healthy volunteers took either a placebo or a capsule containing 300 milligrams (mg) of a dried tulsi leaf extract once a day. After 4 weeks, those who took the tulsi extract had lower levels of cholesterol and triglycerides than those who did not. The authors concluded that the extract could help reduce some risk factors for cardiovascular disease.

Boosting mental health: -

Mental stress can trigger the production of free radicals in the body. According to a 2014 review that looked at the role of tulsi in Ayurvedic medicine, the plant contains properties that may help: alleviate stress, anxiety, and depression, increase the ability to think and reason, prevent age-related memory loss, improve stress-related sleep and sex issues. Some studies, the authors report, produced results comparable to those of diazepam and antidepressant drugs. However, confirming these findings will require more research. Also, consuming tulsi — in a tea, for example — is unlikely to have the same effect as receiving a dosage of an extract.

Reducing inflammation and swelling: -

Oxidative stress can lead to inflammation, a factor in various diseases, including cancer, type 2 diabetes, and rheumatoid arthritis. In 2017, researchers analyzed the anti-inflammatory properties of two preparations of sweet basil essential oil. According to their results, basil oil may help treat various diseases that involve inflammation resulting from oxidative stress.

It is not clear whether eating basil, however, could have the same effect.

Combatting infection: -

Various practitioners of traditional medicine have used basil as an antimicrobial agent, and some scientific research supports this use. In 2013, researchers applied sweet basil oil to various strains of Escherichia coli, or E. coli. The bacteria came from people with respiratory, abdominal, urinary, or skin infections, as well as from hospital equipment. The results showed that the oil was active against these bacteria. The researchers concluded that certain preparations of basil oil could help treat or prevent some types of infection.

- ***Conclusion: -***

Basil is a super herb having lot of health benefits; it is easy to grow &can be grown indoor also; there are many types of basil all are helpful & have medicinal properties; among all sweet basil & holy basil are best to use; its essential oil is very beneficial for health, its oil is costly & should be used pure, its leaves are full phytonutrients having a lot of health benefits; it can be used as salad, cooked with food, eaten raw or drink tea prepared by its leaves, dried powder of leaves are used as herbal medicine; its tablet, capsule & syrup are available in market & can be used in typhoid, dengue, malaria, jaundice cold & cough, respirative diseases etc. So maintain health one should make use of it once or twice a week. Its seeds are soaked in water & drink in sharbat etc, it has a lot of health benefits aswell.